# INDIAN SCIENCE CONGRESS ASSOCIATION

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# PROCEEDINGS
# OF THE
# FORTY-THIRD SESSION
# AGRA—1956

## PART IV

## LATE ABSTRACTS, DISCUSSIONS, LIST OF MEMBERS AND INDEX

*1, Park Street, Calcutta - 16*

# PROCEEDINGS

# OF THE

# FORTY-THIRD

# INDIAN SCIENCE CONGRESS

# AGRA, 1956

## PART IV

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# PROCEEDINGS
# OF THE
# FORTY-THIRD
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## PART IV

## LATE ABSTRACTS

### Section 1, Mathematics

### 1. A Note on Implicit Functions.

H. M. SENGUPTA and B. K. LAHIRI, Calcutta.

We prove here the existence of a unique and continuous function $y = \varphi(x)$ determined implicitly by the relation $f(x, y) = 0$, under the following conditions :—

If (i) $f(x, y)$ is a continuous function of $x$ in a neighbourhood of $a$ given by $a-\varepsilon_1 \leqslant x \leqslant a+\varepsilon_1$, $\varepsilon_1 > 0$, for an every where dense set of values of $y$ in a neighbourhood of $b$ given by $b-\varepsilon_2 \leqslant y \leqslant b+\varepsilon_2'$, $\varepsilon_2$, $\varepsilon_2' > 0$, and is a continuous function of $y$ in the neighbourhood of $b$ for all $x$ in the neighbour hood of $a$,

(ii) $f(a, b) = 0$,

(iii) $f(x, y)$ is a strictly increasing (or decreasing) function of $y$ in the neighbourhood of $b$ for an everywhere dense set of values of $x$ in the neighbourhood of $a$, including $a$ (this everywhere dense set will be denoted by $S$),

(iv) any zero $(\xi, \eta)$ of $f(x, y)$ in the neighbourhood

$$a-\varepsilon_1 < x \leqslant a+\varepsilon_1$$
$$b-\varepsilon_2 \leqslant y \leqslant b+\varepsilon_2'$$

of $(a, b)$ on $x = \xi$, $\xi \varepsilon C(S)$ [$C(S)$ being the complementary set of $S$ with respect to the neighbourhood of $a$], be the limit point of two sequences of points

$$(\xi, \eta+\delta_n), \quad \delta_n > 0, \quad \delta_n \to 0$$
$$(\xi, \eta-\delta'_n), \quad \delta'_n > 0, \quad \delta'_n \to 0$$

such that $f(\xi, \eta+\delta_n)$, $f(\xi, \eta-\delta'_n) < 0$, $n = 1, 2, 3, \ldots$, then

(1) there exists a unique function $y = \varphi(x)$ which when substituted in the equation $f(x, y) = 0$, makes it identically zero in the neighbourhood of $a$.

(2) $\varphi(x)$ is continuous in the neighbourhood of $a$.

### 2. A note on Ostrowski's Generalisation of a Theorem of Osgood.

P. L. Ganguli, Calcutta.

The following results are proved:

*Theorem:* Let $f(t, x)$ be a continuous function of the point $(t, x)$ for $a \leqslant x \leqslant b$ and $t \geqslant T$ and let

$$\lim_{t \to \infty} f(t, x) = f(x),$$

where $f(x)$ is continuous in $a \leqslant x \leqslant b$. Then for every $\varepsilon > 0$, there exists a subinterval $(\bar{a}, \bar{b})$ and a positive number $T_0$ such that

$$| f(t, x) - f(t', x') | < \varepsilon$$

for any pair of points $(t, x)$ and $(t', x')$ lying in the semi-infinite rectangle $\bar{a} \leqslant x \leqslant \bar{b}$; $t \geqslant T_0$.

*Cor.* Given an arbitrary $\varepsilon > 0$, there is an everywhere dense set of non-overlapping intervals $J_n(a_n < x < b_n)$ which we may take to be open, and a sequence of positive numbers $T_n$ such that for any two points $(t, x)$ and $(t', x')$ lying in $a_n < x < b_n$, $t > T_n$, the inequality

$$| f(t, x) - f(t', x') | < \varepsilon$$

holds.

### 3. On the characteristic Polynomial and characteristic roots of the product and powers of matrices.

Omar Ali Siddiqi, Aligarh.

In a recent paper Roth [1] proved the following theorem on the characteristic polynomial of two matrices.

*Theorem I.* If $A$ and $B$ are $n \times n$ matrices with elements on the field $F$, whose characteristic polynomial are $a_0(x^2) - x a_1(x^2)$ and $b_0(x^2) - x b_1(x^2)$ respectively, where $a_0(x)$, $a_1(x)$, $b_0(x)$, are elements in the polynomial domain $F[x]$, of $F$, and if the rank of $A - B$ does not exceed unity, then the characteristic polynomial of $AB$ is $(-1)^n [a_0(x) b_0(x) - x a_1(x) b_1(x)]$.

In this paper I have given a shorter and direct proof of this theorem. I also obtain the following results on ch. polynomials and ch. roots.

*Theorem II.* If $A$ is any $n \times n$ matrix with elements in the field $F$ where the ch. polynomial is $a_0(x^2) - x a_1(x^2)$ then the ch. polynomial of $A^2$ is $a_0^2(x) - x a_1^2(x)$, and the ch. roots of $A^2$ are equal to the squares of the ch. roots of $A$.

*Theorem III.* If $\alpha_i$ are the ch. roots of a $n \times n$ matrix $A$ in a field $F$ then the ch. roots of $f(A)$ are $f(\alpha_i)$ where $f(x)$ is a polynomial function.

*Theorem IV.* If $A, B$ are $n \times n$ matrices in the same field and $\alpha_i, \beta_j$ are their characteristic roots then

(1) the ch. roots of $AB$ are same as those of $BA$ and are equal to $\alpha_i \beta_j$ in an ordered form.

(2) the ch. roots of $A^2 B^2$ are same as those of $B^2 A^2$ and equal to $\alpha_i^2 \beta_j^2$, in an ordered form.

## 4. On reduction of a class of problems in Hydrodynamics to a problem in Electrostatics.

S. D. NIGAM, Kharagpur and S. C. GUPTA, Agra.

The hydrodynamical equations for the slow motion of a viscous fluid past a flat plate bounded by any curve have been reduced to Laplace's equation. The boundary conditions in the plane of the disc are such that the problem reduces to a problem in Electrostatics, which in some simple cases can be solved by the help of Transforms. In the case of flow past a circular disc, treated earlier by M. Ray, the analysis simplifies to the solution of a set of dual integral equations involving Bessel functions. The general problem for any boundary can be worked out by using numerical methods.

## 5. Surface-waves due to an Oscillatory-Point Source.

S. N. SINGH, Kharagpur.

Two dimensional initial-value problem for the propagation of surface gravity waves on the surface of infinite mass of liquid due to an oscillatory point source has been solved with the help of Hankel's transform. If we make the time variable tend to infinity, we get the solution for steady-state problem. Again if we make the space-variables tend to infinity, an outgoing circular wave is obtained the amplitude of which dies out as the square root of the distance from the origin.

## 6. Application of Dirac's $\delta$-function in isolated force problems of semi-infinite elastic solid of isotropic and non-isotropic materials.

G. R. VERMA, Pilani.

In this paper problems of isolated forces acting on the boundary of a semi-infinite solid, composed of isotropic or non-isotropic material have been solved by using Dirac's $\delta$-function. It is shown how Dirac's $\delta$-function can be used with advantage in the problems concerned with semi-infinite solids of isotropic material as well as of those having transverse isotropy.

## 7. Hypo-elastic pure flexure.

P. D. S. VERMA, Kharagpur.

In hypo-elasticity, a subject of very recent origin, Truesdell has generalised the classical linear theory of elasticity i.e., small stress $= f$(small strain from an unstressed state) by taking stress increment $= f$(small strain from the immediately preceding state) or mathematically to begin with

rate of stress $= f$(rate of deformation)

where rate of stress, to be dynamically consistent, is the tensor

$$\tilde{s}^{i}_{j} \equiv \frac{\delta}{\delta t} s^{i}_{j} + s^{i}_{j,k} v^{k} - s^{ik} v_{j,k} - s^{k}_{j} v^{i}_{,k} + s^{i}_{j} v^{k}_{,k} ,$$

$s^{i}_{j}$ being the spatial stress tensor referred for convenience to twice the shear modulus as the unit of stress, $v^{i}$ the velocity, comma the covariant derivative and the rate of deformation is $\frac{1}{2}[v^{i}_{,j}+v^{j}_{,i}]$. He takes a still more general concept of elasticity when he writes $\tilde{s} = f(d, s)$ as the constitutive equation of the ideal material i.e., where response to deformation $d$ is moderated by reigning stress field $s$. With the restrictions (i) no modulus of our ideal material shall carry a dimension independent of the dimension of stress, (ii) $f$ must be an analytic function of the components $d^i_j$ and $s^i_j$, he has established the following matrix (constitutive) equations for an hypo-elastic isotropic body :—

$$\tilde{s} = \delta g_0 1 + g_1 d + \delta g_2 s + M g_3 1 + \tfrac{1}{2} g_4 (ds + sd) + \delta g_5 s^2 + M g_6 s + N g_7 1$$
$$+ \tfrac{1}{2} g_8 (ds^2 + s^2 d) + M g_9 s^2 + N g_{10} s + N g_{11} s^2$$

$$\text{where} \qquad \delta \equiv d^k_k , \; M \equiv s^i_j \, d^j_k , \; N \equiv s^i_j \, s^j_k \, s^k_l ,$$

$$s \equiv \| s^i_j \| , \quad \tilde{s} \equiv \| \tilde{s}^i_j \| , \quad d \equiv \| d^i_j \|,$$

and $g$'s are dimensionless analytic functions of the principal invariants of $s$; for different grades $g$'s are defined in a particular problem. Equations of motion and mass have to be taken as in Elasticity theory. Boundary conditions are also the same. Stress-strain relations are not assumed. Truesdell has already discussed problems on simple shear and torsion.

In this paper we have discussed the steady bending of a narrow but thick rectangular plate of constant density into a circular form of hypo-elastic isotropic material of grade zero. We find.

$$\left.\begin{array}{lll} s^r_r = \dfrac{a^2}{2r^2} - \tfrac{1}{2} , & & s^r_\theta - 0 \\ s^\theta_\theta = -\tfrac{1}{2} & , & s^\theta_z = 0 \\ s^z_z = 0 & , & s^r_z = 0 \end{array}\right| \quad \text{system of stresses}$$

The displacements appear as

$$u = \frac{a}{r} \sqrt{\frac{\mu}{\rho}}, \qquad v = 0, \qquad w = 0$$

where $\mu$ is elastic constant. '$a$' is the inner radius of the cylinder.

This shows that forces must be applied to the straight edges and the curved surface of the tube so as to keep the plate in the circular form.

## 8. On Apparently Adiabatic Motion of Gases.

A. S. Gupta, Kharagpur.

In all motions connected with the gases, question regarding heat are generally suppressed a relation of the type

$$p \propto \zeta^{\gamma}$$

is assumed. We raise the question, "Will such a relation hold even when there is heat transfer going on between the parts of the fluid ?" The state of fluid in such case is thus pictured as an apparently adiabatic motion in which $\gamma$ is not necessarily $\dfrac{c_p}{c_v}$ .

In this note a spherically symmetrical distribution is considered and the problem solved by a particular type solution known as homologous change. We have come to the conclusion that apparently adiabatic radial motion is possible if the gas starts from certain initial distribution and $\gamma = \frac{4}{3}$.

Similar results in plane and axial fluid are expected.

## 9. On the steady laminar flow of certain non-Newtonian liquids through an Elastic Tube.

M. N. I. NARASIMHAN, Kharagpur.

The flow of certain non-Newtonian liquids through an elastic tube has been considered by taking account of the second order terms in the stress-strain velocity relations of classical Hydrodynamics. The conditions have been examined, under which the solutions obtained are valid. It is found that the effect of cross-viscosity is of opposite nature to that of inertia. Furthermore it is shown that the effect of cross-viscosity is to increase the radius of the tube with distance along the axis, though this effect is not sufficient to compensate the effect of viscosity and inertia.

## 10. Wave Resistance due to the uniformly accelerated motion of a pressure system.

R. N. BHATTACHARYA, Calcutta.

In an earlier paper by the author the surface elevation of the wave generated by the uniformly accelerated motion of a pressure system over the undisturbed surface of deep water was worked out in the form of an infinite repeated integral. This integral was analysed into three parts and evaluated by the method of integration by parts and Kelvin's method of group approximation.

Defining wave resistance, after Sir T. H. Havelock (1917), as the horizontal component of the pressure, integrated over the entire pressure region, it is found in this paper that the wave resistance has three component parts $R_1$, $R_2$ and $R_3$ corresponding to the three surface elevations stated above. Of the three parts $R_3$ represents the exclusive direct effect of acceleration and $R_1$ and $R_2$ are analogous to Sir Havelock's results for uniform motion of the pressure system. As in Sir Havelock's result $R_2$ is small in comparison with $R_1$ and represents a small deviation effect dying out with time. But $R_3$, which exists as long as the acceleration lasts, is twice as large as $R_1$. This result is very important for it shows that the wave resistance to the motion of the ship is far greater when it is acquiring its desired speed than when that speed has already been attained.

A particular example has been worked out numerically and the graphs drawn. The graphs show qualitative agreement with experimental results.

## 11. Disturbances of Cylindrical origin in an Isotropic Elastic medium.

S. K. CHAKRABORTY, Calcutta.

The paper deals with the investigations of Disturbances in an infinite homogeneous isotropic and perfectly elastic medium produced by a source operating on a small portion of the inner surface of a cylindrical hole.

Problems considered in this paper are those of: (i) Disturbances produced by a normal stress over a narrow band of the surface of the cylindrical hole; (ii) Disturbances produced by an axial shear over a narrow band of the inner surface of the cylindrical hole; (iii) Disturbances produced by a localized torsional forces over a small portion of the inner surface of the cylindrical hole.

## Section II, Statistics

### 1. On the unboundness of Infinitely Divisible Laws.

S. D. Chatterjee and R. P. Pakshirajan, Lucknow.

It is proved that a proper infinitely divisible distribution is necessarily unbounded The proof makes use of the canonical representation of an infinitely divisible distribution due to Kolmogorov and Polya's theorem regarding bounded probability distribution.

### 2. Diffusion by Discrete Movements.

H. C. Gupta, Aligarh.

Discussed briefly by Taylor in 1922, Goldstein published in 1951 a more complete investigation of the problem of diffusion or random migration in a straight line by discontinuous movements. This problem is considered here in greater generality and in addition formulae have been obtained for distributions in the presence of barriers, reflecting or absorbing or partly reflecting and partly absorbing.

### 3. On a Method of Life Testing.

A. Ghosh Majumdar, Calcutta.

Planning an experiment to measure the length of life of individuals in a population presents certain peculiar difficulties. To measure the lengths of the life of all ndividuals in a sample, one has to wait till the last individual dies. This generally takes a lot of time. Life tests are therefore generally terminated before all the individuals die out. The present paper considers a procedure where the members living are counted every $h$ hours for $kh$ hours when the experiment is discontinued. The appropriate statistical analysis for this type of situation has also been developed when the probability density function is of the exponential type.

### 4. On the use of certain transformations in the analysis of certain designs.

V. N. Murty, Rajahmundry.

A simple method of solving the normal equations that one gets in the analysis of design is given, and the method is illustrated in the case of a Balanced Incomplete Block design. The method can also be used in other types of designs.

### 5. On Problems in the Determination of Optimum Conditions.

U. K. Sen, Kharagpur.

The method of steepest ascent used for finding a response surface in the experimental attainment of optimum conditions appears to hold for a restricted system. The approximation of the response surface by a quadric is found quite similar to problems of linear programming or of quadratic programming, which in turn may be reduced to equivalent saddle value problems.

### 6. On certain two sample non-parametric tests for variances.

Balkrishna V. Sukhatme, New Delhi.

Let $X_1, X_2, \ldots, X_n$ and $Y_1, \ldots, Y_n$ be two samples of independent observations from populations with cumulative distribution functions $F(x)$ and $G(x)$ respectively. It is assumed that $F$ and $G$ are absolutely continuous and that they are the same in all respects except that they differ in the scale parameter. The problem considered here is that of testing the hypothesis that the two samples come from the same population.

If the samples come from normal populations, the usual test of this hypothesis is the variance ratio $F$ test which is sensitive to non-normality. Attempts were therefore made to construct non-parametric tests especially by Mood (1954) and Lehmann (1951). The paper considers these tests, specially from the point of view of power. A new non-parametric test is proposed and a general formula is derived for its asymptotic efficiency with respect to the variance ratio $F$ test for scalar alternatives but almost arbitrary continuous distribution functions.

## Section III, Physics

### 1. Slowing down of neutrons in moderators.

V. P. Duggal, Bombay.

A study has been made for the spatial distribution of slowing down neutrons in graphite at different energies using resonance detectors like *Pd* (24 e.v.) and *In* (1.46 e.v.). The neutron age up to thermal energies has also been determined using *Mn* detector covered with *Gd*.

Using a fission source of neutrons, the age of neutrons up to *In* resonance has also been determined in *BeO*.

### 2. Chelation and Raman Effect.

K. Ramavataram, Hyderabad.

Raman spectra of chelate compounds having the carbonyl link reveal that the $C = 0$ frequency is reduced as compared to its value in corresponding non-chelate structures. Chemical and physical data reveal that intramolecular hydrogen bonding makes the chelate molecule a closed system. Investigations on the extent of closedness of this system have been undertaken on chelate substances like salicyl aldehyde, *o*-hydroxy acetophenone etc., by changing the environment of these molecules. Interesting results have been obtained which go to prove that additional hydrogen bonding of chelate molecules does occur, although the magnitude of such effects is very small.

### 3. Absorption and fluorescence spectra of uranyl nitrate solutions.

D. D. PANT and D. P. KHENDELWAL, NainiTal.

Absolute intensity measurements in absorption of uranyl nitrate in the region 5000 A to 2000 A in aqueous solutions at various dilutions have been made. Kasha's observation that eleven peaks observed in such a spectrum form a single electronic transition is shown to be untenable on the basis of intensity and other considerations. Bands have been observed right upto 3170 A, thus the total number of such bands is 16. Our observations show that there must be at least three electronic transitions in the region 4900A to 300A. Comparison with aqueous solutions of uranyl acetate shows the following differences—

(I) The fluorescence spectrum is very diffuse yet has some structure while in acetate the spectrum is continuous.

(II) The *p*H of acetate solutions is higher.

(III) The absorption bands are very much sharper in the nitrate than in the acetate and are less susceptible to dilution. The observations indicate greater tendency towards complex formation in the acetate solutions.

### 4. Wide Tuning Range inverted Interdigital Magnetron.

AMARJIT SINGH, New Delhi.

The resonator of an inverted interdigital magnetron has been formed by joining coaxial line to the anode. The outer conductor terminates at one set of fingers, and the inner conductor is extended to meet the face plate which supports the other set of fingers. The zero order mode of the anode couples very strongly with the TEM mode in the coaxial line. The resonance frequency is thus effectively controlled by a shorting plunger, which slides in the coaxial line.

This arrangement has an advantage over the normal interdigital magnetron, in that the magnetic circuit is not made unwieldy. In cold tests performed with this type of resonator, tuning ranges of the order of 1.8 : 1 have been obtained.

### 5. Fabrication of Multicavity Magnetrons.

AMARJIT SINGH and NAGESH CHANDRA VAIDYA, New Delhi.

Techniques for fabrication of tubes in general and Magnetrons in particular have been developed and the required equipment has been set up. Operating magnetrons have been made successfully. In this paper some of the important techniques have been described. Those include, glass-to-metal seals, brazing in hydrogen atmosphere, formation and coating of heaters and cathodes, final assembly, evacuation of the tube and activation of the cathode.

### 6. Attenuation of Radar Waves by Rain in India.

S. S. SRIVASTAVA and M. K. GUPTA, New Delhi.

The performance of radars is considerably affected in *X* and *K* bands by intervening rain which causes attenuation, distortion and shadowing of distant targets by nearby precipitation echoes. A front line of showers in India very often involves the passage of a radar beam through several hundred mm-hr$^{-1}$ miles of rain which is quite strong to render 3 cm. Radar equipment practically inoperative. Attenuation of radar waves by different intensities of rain in India, from the data available from the Indian Meteorological Department, has been calculated for different wave lengths and decrease in the target range of AN/APS-10 Radar is estimated. A comparison is made between ranges obtained in 3 and 5 cm. bands for different rain intensities and it is pointed out that an all weather search or reconnaissance radar working in the X-band will be very unsatisfactory during monsoons in India.

## 7. Study of Electrolytic Dissociation of X-ray Diffraction-III.

P. N. SHARMA, S. N. DUTTA and S. R. BHATTACHARYA, Lucknow.

In two previous communications (*Procs. 41st and 42nd Indian Science Congress, Pt. III;* 1954, 1955) the present authors have reported investigations on the X-ray diffraction effects of aqueous solutions of acid-salts at different concentrations with a view to studying the progress of electrolytic dissociation of its molecules in solution. A remarkable series of photographs were obtained which portrayed all the changes taking place from the solid state to a state of very dilute solution. It was pointed out that the stepwise dissociation of the acid salts was responsible for the successive changes in the observed patterns and the latter were interpreted as mainly due to the rearrangement of the water molecules by the electric fields of the ions. The extension of the study to the solutions of normal salts naturally suggested itself.

The present paper gives an account of the studies on the X-ray diffraction effects of aqueous solutions of $Na_2So_4$, $MgSo_4$, $(NH_4)_2$, $So_4$ and $CoSo_4$ selected because of their wide variation in type and valence. It has been found that the sulphates in general show abnormal results—as is indicated by other investigations as well-perhaps due to the large amount of polymerisation which they usually undergo in solution. Accurate microphotometering of the patterns is under way with a view to arriving at some definite conclusions.

## 8. An X-ray Study of 1.8 dihydroxyanthroquinon.

A. V. JAGANNADHAM.

The crystals of 1.8 dihydroxyanthraquinone are found to belong to the tetragonal crystal system. The accurate unit cell dimensions have been found by taking rotation photographs and Weissenberg photographs about the three axes. $a = b = 5.624$ A.U. and $c = 31.19$A.U. The density is experimentally found to be 1.455 gm/cc. and the number of molecules per unit cell turns out to be 4. Complete indexing of the Weissenberg photographs about all the axes indicate that the space groups is $C_4^2 - P4_1$, or its enantiomorphic form $C_4^4 - P4_3$.

## 9. Estimation of Bond Ionic Character of C–O linkage from Diamagnetism.

R. M. MATHUR and C. R. KANEKAR, Bombay.

Diamagnetic susceptibilities of a number of coumarin and substituted coumarins have been measured by the Gouy's method. It is observed that the susceptibility of $CH_2$ group determined from hydroxy coumarins and their methoxy derivatives is about one unit smaller than that obtained from coumarins and their methyl derivatives. This diminution appears to be mainly due to the increase of positive charge on carbon atom in the methoxy group as compared to that on carbon in the methyl group. It is possible to calculate the ionic character of $C$–$O$ bond in the methoxy compounds from this diamagnetic data. The estimated value comes out to be 39.0%. The bond ionic character calculated from Hannay and Smyth's expression by using Pauling's values for electronegativity of carbon and oxygen is however 19.5%. The discrepancy probably arises because the Pauling's electronegativity value of carbon is some what higher than what may be expected for $sp^3$ carbon. A new value of 1.8 has been suggested for the electronegativity of $sp^3$ carbon on the basis of Moffit's work. This value is substantiated by the fact that it gives the correct polarity to $C$–$H$ bond; while the Pauling's value yields the reverse polarity. The ionic character of $C$–$O$ bond calculated by using the new value for the electronegativity of carbon works out to be 38.2%, in good agreement with that estimated from diamagnetism.

## 10. On Some Problems of Magneto-Hydrodynamics.

D. S. KOTHARI and F. C. AULUCK, Delhi.

In this paper we have considered the flattening of a gravitational incompressible (infinitely conducting) sphere of radius $R$ and mass $M$ subject to the influence of a magnetic field in the following cases:

1. The field is taken to be uniform ($H$) inside the sphere and outside the sphere it is $kH$ plus a dipole field of moment $\frac{1}{2}(1-k)HR^3$; $k$ is a constant. The component of the field normal to the surface of the sphere is the same inside and outside it. We find that the equilibrium configuration is a spheroid of ellipticity.

$$\frac{\varepsilon}{R} = -\frac{5}{24}(1-k)(7+3k)\frac{H^2R^4}{GM^2},$$

For $k = 0$ (Chandrasekhar—Fermi case), we have $\frac{\varepsilon}{R} = -\frac{35}{24}\frac{H^2R^4}{GM^2}$ and for $k \rightarrow \infty$ (Gjellestad case) $H \rightarrow 0$, and $kH \rightarrow H_0$

$$\frac{\varepsilon}{R} = \frac{5}{8}\frac{H_0^2R^4}{GM^2}$$

For reasons given in the paper these results are different from those obtained by Chandrasekhar—Fermi, and Gjellestad.

2. We next take the field as produced by currents proportional to the distance from the centre. The equilibrium configuration is as shown by Ferraro, an *oblate* spheroid. If we now superimpose on this field a uniform field, such that the resulting field vanishes at the centre of the sphere, and has a constant value $H_0$ at large distances from the sphere, the equilibrium configuration is a *prolate* spheroid.

## 11. Dislocations and Polytypism in Silicon-Carbide Crystals

A. R. VERMA, Delhi.

An experimental investigation of the phenomenon of polytypism observed in Silicon-carbide crystals has been carried out by a combination of multiple beam interferometric techniques and X-ray diffraction methods. It is found that the strength of Burgers' vector of the dislocation as revealed by the growth spirals on (0001) and the c-lattice parameter as measured by X-rays are simply related to each other, lending support to the dislocation mechanism for the creation of polytypes. However, a more exhaustive study of a large number of crystals with complicated growth patterns, and those with mixed disorder, of which several examples have been discovered in the course of this study, points that a modification is needed in the above theory. These modifications are suggested.

## Section V, Geology and Geography.

### 1. Pannaite : A New Serpentinite.

S. M. MATHUR, Calcutta.

Petrographic and chemical studies of the diamondiferous "agglomerate tuff" found in the volcanic vent at Majhgawan near Panna in Vindhya Pradesh show that it is composed almost entirely of a groundmass of various varieties of serpentine ramified with calcite veins and without other primary and accessory minerals characteristic of the true South African kimberlite. Chemical composition shows that magnesia is very low and titania outstandingly high in the Majhgawan rock as compared to kimberlite. The original characters of this rock show that it is a new variety of rock, and it is proposed to give it the name of "Pannaite", after the well-known centre of diamond production in this country.

### 2. Directions of Magnetization in the Deccan Traps.

J. A. CLEGG, D. H. GRIFFITHS *and* E. R. DEUTSCH, Bombay.

Collections of oriented samples of Deccan Trap lavas have been made in the Linga Area (near Chhindwara) and in the Khandala Area (on the Bhor Ghat). The direction of their thermoremanence has been determined by means of an astatic magnetometer. In both areas the majority of the specimens were found to possess consistent magnetization, their azimuths being directed approximately south-east, and their dips downward. The results suggest that at the time of formation of the lava flows concerned, the geomagnetic field had been reversed, and that India was then located in the Southern Hemisphere, at an approximate latitude of 36° S. This implies that at some time during the past 70 million years the whole peninsula has moved a distance of approximately 6,000 kms northwards relative to the geographical poles.

### 3. A Scheme for the Re-classification of the Rewa Series (Vindhyan System).

S. M. MATHUR, Calcutta.

The discovery of the Paisuni beds at the base of the Rewa series has made it necessary to put the classification of this series on a systematic footing for the new additions to fit in. Instead of two sandstone and shale horizons there are now three of each, while there are two new limestones instead of one. The new sandstone occurs below the "Lower" and so the terms "Upper" and "Lower" have been abolished. The older classification gave equal status to all the members without showing the inter-relationship between them. It is now, therefore, proposed to classify the Rewa Series as follows :—

| | | |
|---|---|---|
| Karauli Stage | ... | Diamondiferous Conglomerate |
| | | Sandstone (Old upper Rewa sandstone) |
| Jhiri Stage | ... | Shales |
| | | Diamondiferous Conglomerate |
| Itwa Stage | ... | Sandstone |
| | | Old Lower Rewa Sandstone |
| | | Diamondiferous Conglomerate |
| Panna Stage | ... | Shales |
| | | Limestone (Old Rewa Limestone) |
| Paisuni Stage | ... | Sandstone |
| | | Shales |
| | | Limestone |

## 4. Physical Properties of some Indian Rocks.

S. BALAKRISHNA, Hyderabad.

Rocks made up of poly-crystalline aggregates and having no preferred orientation should be elastically isotropic, exhibiting only two elastic constants. The phenomenon of total internal reflection has been employed in developing a technique for measuring the ultrasonic velocities in rocks using pulsed ultrasonic beams. The present paper gives values for both longitudinal and torsional ultrasonic velocities, as determined by this method in the case of a number of rocks —igneous, sedimentary and metamorphic—which are elastically isotropic. It has been found possible to measure both the velocities within an accuracy of 0·5 per cent in most cases.

The results show that in rocks, both the types of velocities, longitudinal and torsional, lie within a range of 5500-6500 and 2600-3600 meters/sec. respectively. The values in the case of igneous rocks are usually higher than those for the other two types. The variations of both longitudinal and torsional velocities in the temperature range of 3°C to 110°C have been determined in a few specimens. It is observed that the variation is linear and the velocities decrease markedly with increase of temperature. It is also found that these rocks are generally elastically isotropic. Slight departures, if any, from perfect isotropy are attributed to the heterogeneous nature of the rocks. The anisotropy percentage, which is small, is of the same order in the longitudinal and torsional velocities.

## 5. A Preliminary Note on the Occurrences of the newly found Gabbroic Rocks in the Barabar-Nagarjuni hills and Adampur-Sapneri area, Gaya District, Bihar.

R. S. MITHAL *and* F. A. ANSARI, Banaras.

The basic rocks ranging from anorthosite to gabbro and norite are reported for the first time from this area. The outcrops of these rocks occur either in detached blocks or in association with a coarse grained granite and an iron ore deposit. The other rocks found in the area include minor occurrences of phyllites, schists, quartzite, granulite on the one hand and fine grained to coarse porphyritic granite on the other. The basic rocks are massive, medium to coarse grained and are very similar to anorthosites from Mayurbhanj.

## 6. Xenolithic and other Occurrences of Older Rocks in Bundelkhand Granites and Gneisses of the type area.

R. C. MISRA *and* M. N. SAXENA, Lucknow.

The paper gives an account of the xenolithic and other occurrences of older rocks in Bundelkhand granites and gneisses of the type area. The study of the Bundelkhand granites and gneisses in Hamirpur and Jhansi districts of Uttar Pradesh has shown that there are numerous outcrops of schists and quartzites etc., scattered throughout the granitic masses. The nature of the outcrops varies from tiny patches to bands extending for long distances.

The various kinds of rocks met within the xenoliths are :—biotite schist, biotite-muscovite schist, quartzose schist, granetiferous muscovite schist, chlorite schist, calcite bearing chlorite schist, talcose schist, amphibole schist, quartzites (uncontaminated as well as felspathic), ferruginous phyllites and amphibolites.

In most of the cases, however, they have become migmatised and granitised and show veined structure.

The presence of chlorite-magnetite schist in the form of small hill masses near the Saprar dam site, south of Mauranipur town, is noteorthy. This rock has also suffered granitisation. The schistose rocks appear to have a zonal distribution; hornblendic and chloritic rocks being more common in Jhansi district and micaceous rocks being more predominant in Hamirpur district.

## 7. Foraminifera and Palaeoecology of the Miocene (Burdigalian) Beds of Saurashtra, Western India.

S. B. BHATIA *and* KRISHNA MOHAN, Lucknow.

Samples from six different Miocene localities in Saurashtra were examined and the foraminiferal contents analysed. About sixty species were identified, including two new species. On the basis of the smaller foraminifera, the Burdigalian beds are divisible into two zones—Lower and Upper. The Lower zone is characterized by the abundance of *Streblus beccarii* aff. var. *globula* and *Elphidium indicum.* The fauna is rich in the number of individuals though not in the number of species. Sediments belonging to this zone were deposited in shallow transgressive seas over the eroded surfaces of trappean-basalt. The foraminiferal fauna indicates a shallow-water epineritic depositional environment. The Upper zone is characterized by a sudden increase in the number of species. The ecologically significant species occurring in this zone are—*Textularia agglutinans, T. gramen, Clavulina pacifica, Elphidium indicum, Archaias angulatus, Sorites marginalis, Quinqueloculina seminulum. Operculina bartschi, O. granulosa, Ammodiscus incertus,* and *Glomospira gordialis.* Ecological conditions during the deposition of beds belonging to this zone appear to be different from those pertaining during the accumulation of the underlying beds. The contained foraminiferal assemblage indicates an infra-neritic depositional environment for this zone.

## 8. A note on the utilisation of the Iron ores of Salem district, South India.

S. KRISHNASWAMY, Calcutta.

In this note, an attempt has been made to show that like its Swedish counterpart, the Salem magnetite ores, though of poor grade, could yet be concentrated, pelletised, then converted into Sponge Iron by the Wiberg-Soderfors process, and the sponge-iron so produced could be treated in Electric Arc melting furnaces, for the production of high quality steels. Suggestions for the concentration of the Salem iron ores, and details of the pelletising process as now practised in Sweden, and brief notes about the Wiberg-Soderfors process have been included in this note.

Owing to the availability of large supplies of water from the perennial Cauvery river, which flows close-by this well-known industrial town and owing to the presence of a well-established hydro-electric power-supply installation here, Mettur town, lying within 32 miles by railway from the largest iron occurrence, viz. Kanjamalai, has been suggested as the most suitable site for such an Iron and Steel industry. Except for a small amount of metallurgical coal for the manufacture of blast furnace coke, which would have to be imported from the Bengal or Bihar coalfields via Calcutta and Cuddalore ports, and the Soderberg electrodes, which would have to be obtained from abroad, the other raw materials for such an industry lie within an economic distance of Mettur.

## 9. A Note on some Hot Water springs in Bombay State.

S. KRISHNASWAMY, Calcutta.

This note gives a detailed account of the Akloli (Vajreshwari) and Ganeshpuri groups of hot springs in the Thana district, of the Unai springs in the Surat district, and of the Unapdeo springs in the East Khandesh district.

Recent investigations by the author have shown, that while the Unapdeo water can be utilised as a "table-water", provided it is found to be bacteriologically sterile; that there is a possibility of developing the Akloli (Vajreshwari), the Ganeshpuri, and the Unai areas into "Spas", so that these waters belonging to the Chloride or Saline type (with some of them being feebly radioactive), may be utilised by the needy, under expert supervision and controlled conditions. But owing to the fact that the observed and recorded information available about these springs during the past century, (since the days of Giraud and Haines in 1855), had been somewhat inconsistent in regard to such essential particulars, as the chemical composition, discharge, and temperature of the waters of some of them, the author feels that certain further detailed investigations under controlled conditions are necessary, before one can draw final conclusions about the potentialities of these areas.

## 10. A Traverse through Gondwana succession in the Satpura Basin.

K. P. RODE *and* R. T. SHUKLA.

The detailed field study of the Talchir rock formations in the Kanhan Valley near Hirdagarh had shown a consistant intimate association with the trappean intrusives and their derivatives. This close association characterised by graded contacts suggested as intimate genetic relationship between the two and led to the possibility of Talchir clays as being directly derived by decomposition of the trappean material. The occurrence of similar bands at different levels within the Barakars and also the Motur prompted a study of the upper Gondwana formations with a view to see if similar relationships are also to be found in the upper Gondwana formations. A traverse was taken along Chhindwara-Piparia road passing through lower Gondwanas near Parasia followed by Moturs, Deccan traps, Bijoris, Pachmaris, Denwas, Bagras and again through the Talchirs and the trap near Piparia as mapped by Crookshank and this traverse had shown repeated occurrence of Talchir like chrome and variagated clays throughout various formations in upper Gondwana succession. Even here their association with trap intrusives was repeatedly observed and it left no doubt that many of the shaly and clayey bands which occur in these formations and particularly in Moturs and Denwas had intimate genetic relationship with trappean intrusives as was found to be the case with the talchir shales.

## 11. The Ocean Currents and Water Types off the East Coast of India.

E. C. LA FOND, Waltair.

Oceanographic investigations conducted under the auspices of the Andhra University, Waltair, have thrown considerable light on the horizontal and vertical circulation and on the water types along the East Coast of India. From the sea temperature, salinity and density it is convenient to establish water types since (1) water of low density (*Northern Dilute Water*) is formed at one end of the Bay and (2) water of high density (*Southern Bay of Bengal Water*) at the opposite end. Surface currents can be determined by the distribution of these water types or mixtures of them. Vertical circulation can also be ascertained by the orientation of subsurface water structure, for example, in regions of sinking the surface water type extends to greater depth than in adjacent areas and in regions of upwelling the subsurface water types are forced up to or near the surface.

## 12. Land Utilization in Mathura District.

### S. D. MISRA, Nagpur.

The paper deals with the following points in detail :—(1) Land use studies abroad, (2) Position in India, (3) Land use and applied geography, (4) Land use and our food supply, (5) Statistical data of the land use pattern from the district of Mathura--this includes the tables on (i) Land unfit for agriculture, (ii) Land fit for agriculture, (iii) Cultivable land, (iv) Land out of cultivation, (v) Autumn crops, (vi) Spring crops, and (vii) The differentials of the crop area.

Due emphasis has been laid on need for *Conservation*. This includes the following programme :—

A. Increasing the available supply of water by better methods of irrigation, diking, regulating the use of ground water, diverting the rain water, controlling the small streams, and forecasting the water supply. B. Restoration of the ravine lands. C. Checking erosion. D. Purchase of marginal lands. E. Selling conservation to public. F. Other types of conservation.

## 13. Land-use Survey of Rayapur—A sample study.

### L. Y. KULKARNI, Dharwar.

Rayapur is situated on Bangalore-Poona Highway at a distance of six miles from Dharwar and it represents the type of Land-use from this area of the Bombay-Karnatak. This is one of the six villages selected from this area. Its land-use is greatly influenced by the Urban Centres—Hubli on one side and Dharwar on the other side and hence the selection. For this purpose the land-use and the soil survey, the survey of the village proper and the socio-economic survey were carried out. Out of the total area of 1235 acres, 80 per cent is under cultivation, 5 per cent is occupied by roads, railways and buildings, 14 per cent is a grazing land and 1 per cent includes tank and the land under 'non-agricultural purposes'. The climatic conditions of Rayapur favour both Kharif as well as Rabi crops. But the Kharif crop is predominant and occupies more acreage. The soil is poor on one side of the road and at the foot of the hill. More than 75 per cent of the cultivated area is deep black soil mostly given to cotton and other crops. Predominant features of land-use survey of this village can be summed up as under :—

1. There exists a close correlation between the soils of Rayapur and the crops that are produced there.
2. There is a constant pressure on soil as can be seen from the land-use map.
3. There is very little grazing land as well as wasteland and this has put a fullstop to dairy industry of the village.
4. There is overgrazing due to the large number of cattle. Destruction of trees has also taken place recently for various reasons.
5. The present land-use is influenced partly by the geographical factors and partly by the economic and social aspects.
6. There is no more land left that could be brought under cultivation.
7. On the whole, majority of the villagers are well-off, though poorly dressed and uneducated.
8. Agricultural practices are much improved compared to the past and also compared to the other adjacent villages.
9. Change in agricultural pattern of Rayapur is mainly due to the increase in urban population in Dharwar and Hubli which can be seen from the increase in the acreage under potatoes, vegetables, chillies and groundnut.

10. Lastly, their outlook on life, social and cultural activities are largely influenced by these two urban centres situated on both the sides of Rayapur.

## 14. Geographical aspects of Dharwar Market.

### L. Y. KULKARNI, Dharwar.

Dharwar once a small village has developed into a large town in the course of the last century. The town has gained its importance during the recent years as a result of many factors. The nodal position of Dharwar has favoured its growth. It is well connected by roads with the surrounding areas. It is a centre of education and commerce. The Dharwar market is the second largest in the district next to Hubli. Articles sold in the market are mainly to satisfy the primary needs. Villagers derive many advantages by visiting the Dharwar market. It facilitates easy movements of goods and people. It being a District place, there is more demand. Secondly, villagers after selling their produce can purchase cloth, fertilisers, implements and take loans from the Co-operative Societies. Thirdly, there are rice husking mills in Dharwar. Lastly, Dharwar affords many facilities for recreation.

The articles which are brought to the Dharwar market are produced by the sellers mostly in their own fields. The nature of these articles, however, change from season to season. In order to study these changes in the commodities from time to time, to find out whether these articles are produced in the surrounding area or brought from a long distance, whether the neighbouring area is self-sufficient in each of these commodities or otherwise, to find out the shortages and the ways in which they are supplied to the people of this area, the Survey of the Dharwar Market was undertaken.

The Survey of the Dharwar Market was restricted to food-stuffs only. About 900 persons were interviewed from 73 places. The largest group comes from Dharwar proper, then comes Hubli. The number of sellers decrease according to to the increase of distance from Dharwar. Out of these 44 per cent were head-loads ; 27 per cent by carts, which reflects on the standard of living of the sellers. The production of the commodities is largely dominated by the climatic factor. Rice, Jawar and pulses are largely sold after the harvest. Vegetables are sold during the rainy season. However, the Dharwar market has been specialised in rice trade since "Mugad variety" of rice has become popular in the surrounding area. Lingayat community is dominating in agriculture as well as in commerce. Further progress has to be achieved through the cooperative societies by educating the cultivators, by advancing long term loans, by explaining improved methods of cultivation and of grading, by making arrangements for storing the produce and by supplying improved variety of seeds, fertilizers and implements.

## Section VI, Botany.

## 1. The effects of certain synthetic growth regulators on the process of vernalization of *Sesamum indicum* L.

### S. C. CHAKRAVARTI, Bhopal.

Present piece of investigation has been undertaken to determine the effects of prevernalization soaking of seeds with IAA, NAA, 2, 4-D and TIBA in the concentrations of 50, 0·5 and 0·005 ppm. in distilled water on the induction of early flowering in *Sesamum indicum* L., T. 10. Only unsplit seeds were used for experimental purposes.

There was no significant difference in the time taken to flower by plants raised from seeds subjected to a pre-sowing treatment of :—

(*i*) Soaking with water;
(*ii*) Soaking with solutions of different chemicals;
(*iii*) Soaking with water followed by chilling;
and (*iv*) Soaking with solutions of different chemicals followed by chilling.

## 2. Physiologic specialisation in *Colletotrichum graminicolum* (Ces.) Wils.

KHURSHEED ALI, Aligarh.

Large number of isolates of *Colletotrichum graminicolum* (Ces.) Wils. were made from different varieties of sorghum from different localities in the Aligarh district. Out of these, 14 isolates could be distinguished from one another on the basis of several cultural characters such as (*i*) topography, (*ii*) zonation, (*iii*) the amount of aerial mycelium, (*iv*) colour and (*v*) size of the colony. These characters have been constant for each isolate for the last two years.

The isolates also differed in the rate of growth on different media under the same experimental conditions. Besides, some of these isolates also differed in their pathogenicity on different varieties of sorghum.

These studies establish the fact, beyond doubt, that there exists the phenomenon of physiologic specialisation in *Colletotrichum graminicolum*, the causal organism of anthracnose of sorghum.

## 3. Indirect Germination of Conidia in *Peronospora trifoliorum* de Bary.

M. H. FAROOQUI, Aligarh.

Studies were made on the germination of conidia of several species of Peronospora. In *Peronospora viciae, P. parasitica, P. tabicina, P. destructor* and *P. effusa* germination occurred by the formation of germ tubes but in *Peronospora trifoliorum* de Bary on *Melilotus parviflora* Desf. zoospore formation was observed (indirect germination) along with the direct germination under the identical experimental conditions.

## 4. Studies on mineral nutrition of three isolates of *Helminthosporium sativum* Pam. King & Bakke.

ABRAR M. KHAN *and* M. A. SIDDIQI, Aligarh.

Studies were made on the effect of mineral elements on the growth of three races of *Helminthosporium sativum*. Each element whose effect was to be determined was eliminated but replaced by another element. The races differed as to the effects of different elements on the rate of their growth.

Race 3 grew profusely while race 1 and 2 less so. The elimination of nitrogen from the culture medium retarded the growth of all the three races. On the other hand, elimination of all the other did not affect their growth appreciably. No differences were observed in pH of the medium and colour of the mycelial mat.

The races 1 and 3 did not sporulate even after five days when nitrogen, potassium, phosphorous and magnesium are eliminated. The races 2 also did not sporulate in the absence of nitrogen and potassium. It did sporulate on fourth day on a culture medium lacking phosphorous and magnesium.

## 5. Pathogenicity of three races of *Helminthosporium sativum* Pam., King & Bakke, against recommended barley varieties.

ABRAR M. KHAN *and* M. A. SIDDIQI, Aligarh.

*Helminthosporium sativum* Pam., King and Bakke is responsible for great damage to barley in Aligarh district. Studies were made to find the varietal resistance of this crop against the three races of the fungus namely A, B and C.

Race A is highly pathogenic to barley varieties C 50, C 84, C 251 and less so to varieties K 12, C.N. 292, C.N. 294 and N.P. 21. Race B is similar in its pathogenicity to Race A. Race B also resembles to Race A in the degree of its virulence. On the other hand Race C is weakly pathogenic on all the varieties tested.

## 6. Varietal resistance of recommended wheat varieties against three races of *Helminthosporium sativum* Pam. King & Bakke.

MOID AHMAD SIDDIQI *and* ABRAR M. KHAN, Aligarh.

Blight of barley caused by *Helminthosporium sativum* Pam. King and Bakke is responsible for causing great damage to the crops by killing the plants or by producing badly shrivelled grains. Experiments were made to find out the varietal resistance against three isolates of the fungus arbitarily named as races A, B and C.

The three races, A, B and C exhibit varying reactions on wheat varieties. Race C is less pathogenic than either A or B. A and B exhibit almost the same reaction on varieties C 13, N.P. 710, N.P. 720, Pb 791, C 46, N.P. 775, N.P. 125 and N.P. 52. Variety N.P. 52 is highly susceptible to race B while Pb 591 is less so.

## 7. *Leaf curl of Papaya.*

ABRAR M. KHAN *and* P. R. MEHTA, Aligarh.

Leaf curl of papaya is quite common in North India. It has been attributed to Virus. The disease condition is associated with the galls on the roots induced by a *Meloidogyne marioni*. The infected plants become stunted with a crown of twisted dark green leaves and curled petioles. Infection tests show that the nematode attacks a variety of hosts like bean, *Phaseolus mungo;* brinjal, *Solanum melangena;* tomato, *Lycopersicum esculentum;* papaya, *Carica papaya; Ficus carica;* and *Impatiens balsamina.*

## 8. Cytological studies in the tribe *Andropogoneae, Gramineae.*

S. M. SIKKA *and* K. L. MEHRA, New Delhi.

Cytological investigations in the tribe Andropogoneae, Gramineae, were until recently confined only to the determination of somatic chromosome numbers of its various species. An extensive study of the chromosome numbers and the meiotic behaviour of all the species belonging to this tribe has been initiated at the Indian Agricultural Research Institute. The present work outlines the details of cytological investigations conducted in 52 geographical collections of grasses belonging to 19 species and 10 genera of this tribe.

The gametic chromosome number was reported to be n = 10 in *Chrysopogon montanus, Cymbopogon nardus, Dichanthium annulatum, D. sericeum, Erianthus munja, Imperata cylindrica* and *Vetiveria zizanioides.* All these strains showed a regular meiosis. Ten bivalents were observed at MI in all these species.

The gametic chromosome number was reported to be n=20 in *Andropogon gayanus, A. ischaemum, A. caucasica, Cymbopogon martini, Hyparrhenia rufa, Bothriochloa pertusa, B. intermedia, B. odorata, B. glabra, Dichanthium annulatum, D. caricosum*, and *Heteropogon contortus*. Besides these, the gametic chromosome number was reported to be n=25 in *Andropogon ischaemum;* 30 in *Heteropogon contortus, Bothriochloa insculpta* and *B. intermedia,* and 40 in *Chrysopogon montanus*.

Tetrapoloid plants of *Dichanthium annulatum, D. caricosum, Andropogon ischaemum, Heteropogon contortus, Bothriochloa glabra, B. odorata, B. intermedia,* the pentaploid *A. ischaemum,* and hexaploid plants of *H. contortus, B. insculpta* and *B. intermedia* showed varying degree of cytological irregularities during meiosis. Chromosome associations and chiasma frequency was studied at diakinesis and MI in all the geographical collections of these grasses. Multivalents were observed besides bivalents and univalents Laggards and dividing univalents were also observed at AI. Cytokinesis was observed to be irregular. Pollen grains showed variation in diameter.

Chromosome races within a taxonomic species of this tribe have earlier been reported in *Bothriochloa intermedia* (Oke, 1950), *Heteropogon contortus* (Celarier and Harlan, 1953; Mehra, 1954), *Schima nervosum* (Mehra, 1955) and *Chrysopogon montanus* (Mehra, 1955).

In view of meiotic irregularities and polyploidy, it is concluded that the tribe *Andropogoneae* has undergone an extensive cytological evolution in the recent past.

## 9. On the frutification of *Tricoccites trigonum* Rode, from the Deccan Intertrappean Series of India.

MRS. S. D. CHITALEY, Nagpur.

The paper deals with the investigation of fructification of *Tricoccites trigonum* Rode, and redescribes the fruit in as much detail as possible. The fresh specimens are collected from Deccan Intertrappean beds of Mohgaon Kalan, Chhindwara District, Madhya Pradesh, India.

The previous diagnosis of the genus *Tricoccites* is amended as follows :

Elongated fructification composed of closely packed fruits, probably enclosed in several ensheathing leaves. Fruit 3-locular, 3-seeded drupe; shape triangular in transverse section, or rounded or truncate in longitudinal section. Fruit wall with three main regions; outer region thin, fibrous; middle region broad, divided by radial plates of fibrous tissue alternating with soft tissue or spaces; inner region richly fibrous and thick. Loculi rounded in cross section occupying angles of fruit, with one vertical large seed in each. Seed attached by placenta extending from base of loculus up along its outer edge. Testa of three regions : Embryo not preserved.

Specific diagnosis of *Tricoccites trigonum* is also amended from further investigation of the fruit. Structure of the sheaths show several striking points of agreement with the leaf and leaf-sheaths of *Cyclanthodendron Sahnii (Rode)* Sahni and Surange. This interesting matter needs further investigation from better specimens to clarify the doubt, if the sheaths belong to *Tricoccites* and secondly if they do, that they belong to *Cyclanthodendron*. It is worth this investigation for the fruits are different from those of the living Cyclanthaceae.

About the affinity of the fruit, the closest agreement is seen with *Attalea*, a 3-locular, 3-seeded drupe of Palmae. There is however no generic affinity, for the fruits of *Attalea* form a loose fructification and are of different shape. If the sheath leaves belong to *Tricoccites*, they can be readily matched among the Palms It seems reasonable to refer *Tricoccites*, tentatively, to the Palmae as an extinct genus.

### 10. Evolving wilt resistant strains in Tur (*Cajanus cajan* L.).

DR. SYED VAHEEDUDDIN *and* MR. S. N. NANJANDIAH, Hyderabad.

Tur wilt (*Fusarium udum*) though appearing sporadically in the State of Hyderabad causes an annual loss of about a lac of rupees. With a view to evolve wilt resistant strains, material from wilt infested areas was collected. The work was carried out at the Sangareddy Agricultural Research Station. For this purpose, compost made out of wilted plants was nicely spread in one plot and thus an area thoroughly infected by wilt was made available. Samples collected as mentioned above were planted in this plot and a systematic selection of wilt resistant plants was made year after year. The work commenced with 14 samples in 1st year 1943-44 and in subsequent years the work was confined only to the selected plants and their progeny found resistant. By 1948-49, 3 lines showing resistance to the extent of 80-90% were isolated. In each year care was taken to see that the plot was thoroughly infested with wilt fusarium udum and the material to be tried was flanked on either side by susceptable local to serve as control. Thus, at present we have isolated 3 strains namely S.T. 1, S.T. 2, and S.T. 3 showing a range of resistance of 80-90%.

### 11. Phytosociological Study of the Association of *Astercantha longifolia* and *Cyperus albomarginatus*.

F. R. BHARUCHA *and* V. M. MEHER-HOMJI, Bombay.

Phytosociological survey of Astercantha longifolia Nees. association was under taken according to the methods of Braun-Blanquet. This association is named after Asteracantha longifolia, the dominant species and Cyperus albomarginatus, the most characteristic species. The characteristic exclusive species are Cyperus albomarginatus and Cyperus dilutus. This association is rich for it contains as many as 94 species which are divided into seven groups—characteristic exclusive and preferential species, Species of Order and Alliance, Facies Species of Halophytes, Companion Species and Accidental Species. The allied hydrophytic associations are grouped in the order of Sphaeranthus indicus. Finally, it is shown that the present association is not seasonal but that it exhibits two aspects—monsoon and winter according to the seasons.

## Section VII, Zoology and Entomology.

### (i) *Protozoology.*

### 1. The effect of Urethane on Growth and Division rate of *Spirostomum ambiguum.*

B. R. SESHACHAR *and* P. B. PADMAVATHI, Bangalore.

Ethyl urethane (Sat. solution in water) added in small quantities (2 drops in 1 c.c. culture fluid) produces a profound effect on division rate of *Spirostomum ambiguum.* An analysis made over 3 weeks shows that there is an initial lag in fission rate followed in the second week by a highly accelerated rate of fission. At the end of the second week, the animals resume the normal rate of fission of once in four days.

These phenomena are explained as being due to the production, in the cell, of two substances, one of which inhibits division rate, while the other counter-acts it and tends to restore to the normal. A detailed analysis is presented in the paper.

## 2. The micronuclei of *Spirostomum ambiguum* during regeneration.

B. R. SESHACHAR *and* P. B. PADMAVATHI, Bangalore.

Observations on the life-cycle of this Spirotrichous Ciliate showed that the number of micronuclei was subject to considerable variation, sometimes as few as 20, at others as many as hundred, being found. Consistently, however, about 20-30 were found to take part in mitosis during binary fission (Padmavathi, 1955a and 1955b). There was evidently a process of increase as well as decrease of micronuclei going on in the organism. To understand this phenomenon of micronuclear variation and also to account for it, a series of regeneration experiments was executed during which animals were cut into 2, 4, 6, 8 and 12 fragments. The fragments were allowed to regenerate for 48 hours and later fixed and stained and the micronuclei counted. It has been established that the micronuclei increase in number during regeneration and it seems probable that the micronuclear substance offers the source of this increase.

### (ii) *Crustacea.*

## 3. Studies on the Sinus Gland of Crustacea.

RUBY DANIEL, Madras.

A study of the morphology and histology of the sinus gland and x-organ in *Squilla holoschista* and *Ocypode quadichaudii* has been made. The sinus gland of *Squilla holoschista* (unlike in *Squilla mantis*) is situated between lamina ganglionaris and medulla externa. In shape it differs from the latter in resembling both inverse and everse types of gland. In the presence of two distal ventral folds and a dorsal fold the gland appears to be unique. The histological features of the gland are similar to those in other Malacostraca in consisting of very few nuclei and in absence of cell walls. The x-organ of *Squilla holoschista* differs from that of *Squilla mantis* in being undivided into two parts and situated distal to the medulla terminalis. The cells show varied cytological inclusions found in the cytoplasm which suggest that they represent different stages in the production of the secretory substance. The secretory droplets in the sinus gland of *Squilla holoschista* are of three types which recall the colloids A, B and C described in *Sesarna dahaani* (Enami 1951). Evidence is cited to suggest a transformation of one type to the other.

## 4. The development and metamorphosis of three species of sessile barnacles.

A. DANIEL, Madras.

The early development, duration of larval life, and the complete description for six naupliar and cyprid stages of *Balanus amphitrite variegatus* are given. The attachment of the cyprid larva and the different phase of orientation are dealt with in detail. The developmental stages of *Balanus tintinnabulum tintinnabulum* are briefly sketched and are compared with that of *B. a. variegatus*. The developmental stages of *Chtamalus stellantus stellatus* are described. Bassindale's accounts are discussed.

## 5. Colour as a factor influencing the settlement of barnacles.

A. DANIEL, Madras.

Experiments show that the three Madras species of sessile barnacles which foul timber settle in maximum numbers on red, black and white panels in preference to those of blue, green and grey colour, grey panels being the least fouled. The results of the experiment further show that the reactions of the cyprids to colour may be based on a complex of several factors rather than a sample direct relation to different parts of the spectrum.

## 6. Lernaeid Copepods parasitic on Flying Fish.

C. P. GNANAMUTHU, Madras.

Species of the genus *Pennella* are of interest because of their ability to parasitise widely different hosts such as the warm-blooded Cetacea as well as the cold-blooded fish, and have been found on fishes differing markedly in habit. They are also of interest because the same species infests several species of fish hosts. Four different species of*Pennella* (*P. robusta, P. platycephalus, P. elegans,* and *P. longicauda*) parasitic on Indian flying fishes are described for the first time.

## 7. Structural peculiarities of the psammophilous copepods.

S. KRISHNASWAMY, Madras.

The peculiarities of the structure of psammophilous copepods show a close degree of harmony between the environment and the animal, and species belonging to different families have a number of features in common. The majority of the sand-dwelling copepods are less than a mm. in length and are either cylindrical and vermiform (e.g. *Evansula*) or dorso-ventrally compressed (e.g. *Emertonia*). The antennule, antenna, and the mouth parts are reduced. The exopods of the legs are reduced, 2-jointed in *Psammoleptastacus* and 1-jointed in *Psammastacus* or is completely lost as in *Psammopsyllus*. The endopod is also reduced and is 1-jointed (*Emertonia*) or absent (*Leptopsyllus*). In *Sewellina*, a new genus from Madras, the exopod of the first leg is absent, the rami of the second and the third legs are 1-jointed and the fourth leg is represented by a lamina. The setae are fewer in number and are geniculate.

## 8. Notes on the bionomics of the psammophilous copepods of Madras.

S. KRISHNASWAMY, Madras.

In spite of the keen interest evinced in the taxonomy of the psammophilous copepods, our knowledge of the bionomics of these forms is very scanty. The availability of these copepods in large numbers at Madras made it possible to make a few observations on the locomotion, reaction to light, ability to withstand desiccation, toleration of salinity changes. While at bottom of the vessel, these copepods crawl about with the help of legs or wriggle about like worms, by the undulations of the thoracic as well as abdominal segments. Some of these copepods are phototrophic (e.g. *Leptastacus euryhalinus*). All these are highly thigmotactic. They retain their activity even when the moisture content of the sand is as low as 15% and withstand variations in salinity from 33% to 15%. Two epizoic protozoans, a vorticellid (on *Neoleptastacus* Sp) and a suctorian (on *Arenosetella* Sp.) have been recorded.

## 9. Chromatophorotropic activity of the neurosecretory cells of the thoracic ganglion of *Paratelphusa hydrodromous* (Herbst).

K. K. NAYAR *and* R. PARAMESWARAN, Trivandrum.

Three types of neurosecretory cells designated A, B and C are present in the thoracic ganglion of the crab, *Paratelphusa hydrodromous*. Using the common fresh water shrimp *Caridina sp.*, as the test animal it has been possible to show by a series of injection experiments that the B cells produce a chromatophorotropic principle which brings about a concentration of the red chromatophores in eyestalkless test animals. This result agrees with the findings of Matsumoto (1954) for the crab, *Eriocheir* where young crabs of the same species were used as test animals.

## 10. Studies on the manufacture of semidried prawns, with reference to the levels of moisture and sodium chloride in the finished product and the percentage yield.

R. VENKATARAMAN *and* A. G. VASAVAN, Kozhikode.

Semidried prawns are prepared by blanching and shelling the prawns and drying the pulp obtained. The levels of moisture and sodium chloride in the different stages of processing are estimated and the percentage yields for different species at varying moisture contents were worked out. The yield of finished product varied from 15-25%. The moisture content in the finished product was 40-45% and the sodium chloride content 20-25% (on dry basis). The yield of raw pulp was 30-40% of the weight of raw prawns and the weight of dried pulp was 55-65% of the raw weight of the pulp. A study of the keeping quality of semidried prawns at various levels of moisture content was also made and it was observed that a moisture content of 42 5% is the optimum considering the keeping quality and the texture of finished product.

## (iii) *Entomology.*

## 11. Studies in Semiaquatic Orthoptera.

A. P. KAPUR, Calcutta.

On account of the abundance of streams and rivulets in many parts of India, one comes across an interesting variety of Orthoptera which lead a semiaquatic mode of life. The writer records observations on several semiaquatic species of Blattidae, Acridiidae, Tetrigidae and Gryllidae occurring in Bihar and West Bengal.

The Blattidae (*Stictolampra plicata*) remain partly covered by water among debris and stones at the edges of streams and have specially modified posterior pair of spiracles which if necessary protrude out of water to draw the air. Their food consists of decaying vegetable and animal matter but in the laboratory they could be bred on blotting paper, dog-biscuits and yeast. The Acridiidae (*Gesonula punctifrons*) on the other hand feed on green vegetation which grows in and around water. Normally living freely on their host plants they will dive into water when disturbed and swim actively with the aid of the hind pair of legs, the tibiae and tarsil of which are flattened. They have serrated ovipositor with which they saw into plants for egg laying.

The Tetrigidae (*Scelimena harpago*) inhabit small streams or large rivers and usually remain submerged in water except for the head and the anterior part of pronotum. With least alarm, they also go under water apparently carrying a supply of air beneath the pronotum, with the result that they are able to remain there for a long time. Like the Acridiidae, they also swim fast and have serrated ovipositor. The Gryllidae (*Pteronemobius pictus*) usually occur rather gregariously on boulders surrounded by water in streams or rivers. When disturbed, they jump and hop freely on the surface of water with the aid of hind pair of legs which are modified for the purpose. They neither enter water nor get wet and are apparently the least adapted to aquatic life.

## 12. Larva and pupa of *Aedes* (*Stegomyia*) *w-albus* Theobald, 1905 (DIPTERA-CULICIDAE).

P. K. RAJAGOPALAN, Poona.

Barraud (1934) in his monograph on culicine mosquitoes of India, stated that the larvae of *Aedes w-albus* were unknown. This paper is meant to provide such descriptions based on the examination of larval and pupal skins which were determined to be those of *Aedes w-albus,* from the resulting adults. Barraud had followed the nomenclature of the chaetotaxy of the larva as proposed by Edwards and Given (1928) who takes into account only five important hairs on the fronto-clypeus, whereas in this paper the nomenclasure used in the description of the larva is that of Belkin (1950) who takes into account all the hairs. The nomenclature used in the description of the chaetotaxy of the pupa is that of Knight and Chamberlain (1948) as revised by Belkin (1952). The larva resembles very closely with the larva of *Aedes* (*Stegomyia*) *albopictus* another common *Stegomyia* of India, and the important points of differences are also mentioned.

## 13. Neurosecretory pathways in the insect *Iphita limbata* Stal.

K. K. NAYAR, Trivandrum.

Neurosecretory cells i.e., neurons with pronounced glandular activity and their axonic pathways could easily be followed up in many insects by a staining in Gomori's chrome alum-haematoxylinphloxin. The brain of *Iphita limbata* Stal (Pyrrhocoridae : Hemiptera) bears two clusters of median neurosecretory cells in the pars intercerebralis, each cluster having sixteen cells. The axons of these secretory neurons pass ventralwards and crossing each other, emerge posteriorly as the nervi corporis cardiaci. Each nervus is connected to the corpus cardiacum forming a pathway for transmission of neurosecretory colloids to that gland. The allatic nerve transmits the neurosecretory material to the corpus allatum. The recurrent nerve also shows abundant neurosecretory colloids. Probably the neurosecretory material pass into the blood at the anterior end of the aorta where these colloids could be seen in many preparations.

## 14. Preliminary observation on the oothecae formation of the species *Aspidomorpha miliaris* (Family Chrysomelidae, Order Coleoptera).

D. MUKERJI *and* P. BANNERJEE, Calcutta.

The oothecae formation in *Aspidomorpha miliaris* is quite remarkable owing to its lateral outgrowths. The oothecae is cylindrical and membranous. It is divisible into fourteen compartments. Each compartment has four eggs arranged in linear manner. In all there are fifty-six eggs. These eggs are seen through the transparency of the oothecae. The oothecae were collected from the garden of the University College, Ballygunge, Calcutta in November, 1954. They occur on the leaves of *Ipomia.* The oothecae are attached to the ventral surface of the leaves by lateral outgrowths of the oothecae.

## 15. Insect Fauna of Pilani I. Hemiptera.

S. N. MATHUR, P. K. B. MENON *and* S. R. V. RAO, Pilani.

In this present paper the authors have recorded some of the common Hemipteran inhabitants of Pilani (Rajasthan). Pilani is a part of Rajasthan where prevails a semi-arid condition. These bugs do a considerable havoc to the plants in these regions and in this paper is given an account of these bugs in relation to their hosts, and the time in which they are found abundantly. A good number of aquatic bugs are also observed. In all 23 bugs out of which many are plant feeders, while the rest are aquatic. This is only a preliminary study to the Ecological survey of Pilani--which is under progress.

## 16. Some newer insecticides for the control of kutra—*Amsacta moorei* Butler.

SARDAR SINGH *and* JARNAIL SINGH, Ludhiana.

BHC 10% dust at 40 lbs. per acre proved to be very effective for the control of Kutra caterpillars and almost complete mortality was obtained within six hours of the treatment, when the sun was bright. Results with BHC ·25% suspension were as satisfactory. Endrin 0·05% emulsion and Basudin ·05% emulsion at 100 gallons per acre also proved satisfactory both in the laboratory and field trials.

Under the prevailing market prices, the cost of insecticide for treatment of an acre field infested with Kutra works out as under :—

| | Insecticide needed per acre | Cost of insecticide per unit | Cost of required insecticide per acre |
|---|---|---|---|
| BHC 10% dust ... ... | (*i*) 40 lbs. | Rs. 400/- per ton | Rs. 7/8/- |
| | (*ii*) 60 lbs. | Do. | Rs. 11/4/- |
| Endrin ·05% emulsion ... | 100 gallons per acre | Rs. 65/- per gallon 19·5% E.C. | Rs. 16/4/- |
| Basudin ·05% emulsion ... | Do. | Rs. 120/- per gallon 20% E.C. | Rs. 30/- |

BHC 10% dust remains the effective and economic control measure for Kutra. From the preliminary studies reported above, Endrin 0·05% emulsion and Basudin 0·05% emulsion appear to be equally effective. These insecticides at the above concentrations appear to be uneconomic at the current marketing prices of the two insecticides. Their use has to await either a substantial reduction in their marketing prices or reduction of the two required dosage as a result of further laboratory and field trials.

## 17. Destruction of nests of mound building termites.

SARDAR SINGH *and* PRITAM LAL SHARMA, Ludhiana.

Different strengths of DDT, BHC and Aldrin were tried for the destruction of white-ant nests of the mound building species. Aldrin emulsion consistently resulted in the destruction of the colonies and even 0 0041% concentration (½ tola 40% Aldrin E.C. in 60 seers of water) was sufficient for the purpose. BHC 0·1% suspension at 60 seers per colony though effective could not be depended upon to completely destroy all colonies. Very high doses of DDT were required for destroying the termite nests.

It is recommended that about one tola of Aldrin 40% E.C. in 60 seers of water may be poured in the broken off freshly built pyramid of the mound of an average sized colony (16′-11″ Girth and 2′-9″ height). For very large mounds double the quantity of the above concentrate of the insecticide may be used. Aldrin 40% emulsifiable concentrate is currently quoted at Rs. 48/8 per gallon and the cost of one tola of the material works out at less than two annas.

## 18. Some field observations on the colour variations in *Chrotogonus* (Acrididae, Orthoptera).

ASKET SINGH, Hoshiarpur.

There is a considerable variation in the colour of the dorsal surface of the body and the appendages of *Chrotogonus sp.* (probably *C. trachypterus*). Ventrally all the individuals are milky white with black rounded spots all over. Another uniform feature in their colouration is the presence of a white transverse band running across the face just below the compound eyes and continued posteriorly along the ventral margins of the deflexed lobes of the pronotum. On account of the variations in the colour of the dorsal surface, however, the species can be divided into four major divisions. Majority of the individuals, about 70% are light *khaki* in colour. The second category of individuals are like the first in general colouration but with posterior half of pronotum and basal, dorsal region of the hind femora white. Such individuals constitute 15-20% of the population. The third and the fourth categories which are less numerous, are dull ochre and blackish respectively. It may be added that there are intermediate forms between all four categories described above. All the forms are found throughout the year together. Copulation has also been observed between the various forms in the field and in the laboratory. There are variations in the length of hind femora also, but no correlation between their size and the colour variations described above could be established.

The influence of weather on the colouration of various categories is under investigation to see if there are seasonal changes.

## 19. Preliminary observations on a mite infestation on the grasshopper *Chrotogonus.*

ASKET SINGH, Hoshiarpur.

D. K. McE. Kevan in a review of the work on the genus *Chiotogonus* states that the mite infestation of this genus is very rare. In the case of *Chrotogonus* sp. (probably *C. trachypterus*) found in Hoshiarpur area (Punjab, India) however, more than fifty per cent of the adults and the nymphs were found infested during the month of October. The adults and the nymphs collected from the same localities in November showed less than 1% infested individuals. Obviously the parasite remains active during the warm and humid weather.

The most commonly infested regions of the body are the cervical membrane, the bases of the coxae and the hind wings. The mites do not confine themselves to soft parts only, but they have been observed attached to hard parts also viz. the head capsule, the pronotum, the legs etc. with their mouth parts fixed on the body wall.

In the adults when heavily infested, the most damage is done to the hind wings which become very badly punctured and torn up, with the result that they become entirely useless even for short flights.

Further work on the mite is in progress,

## 20. Preliminary observations on the effect of light and temperature on the feeding activity of the Desert Locust *Schistocerca gregaria* Forsk.

ASKET SINGH, Hoshiarpur.

It is well known that the feeding activity of the locust swarms practically ceases during the night. They start actively feeding after the sun rise when it warms up. To determine whether the low activity during the night is due to fall in temperature or darkness, the quantities of cabbage eaten by hoppers and adults under different temperatures, and during day and night times at a constant temperature have been determined. In an experiment, two groups (Fd 1 and Fd 2) each consisting of 20 V stage hoppers were placed in a well lighted room. One of these (Fd 1) used to be exposed to the sun from 10 A.M. to 6 P.M. daily during the month of January, Fd 2 served as control. During eighteen days Fd 1 hoppers consumed food as much as four and half times more in weight than the control. At nights though both the groups remained at the same temperature, the Fd 1 hoppers consumed three times the quantity of food eaten by Fd 2 group. This seems apparently due to the stimulus which the exposure to the sun gave to the appetite of the Fd 1 hoppers. Furthermore whereas the Fd 1 hoppers consumed at an average of about 6 gms. of food on bright sunny days, between 10 A.M. and 6 P.M. per day, on the cloudy days when the temperature was considerably lower, they consumed only about 1·6 gms. per day.

In another experiment, twenty adult locusts were placed in a room of which the temperature remained almost constant (80°F.). In the day time there was sufficient light in this room. The food consumed by these adults during the night was about half of that consumed during the same number of hours in the day.

Thus it is concluded that temperature and light, both govern the feeding activity of the locust.

## 21. Skeleto-muscular system of the Red Cotton Bug *Dysdercus koenigii* Fb. (Heteroptera: Pyrrhocoridae). Pt. I. The Head and Organs of Ingestion.

SUDARSHAN KUMARI, Delhi.

The skeleto-muscular system of the head of *Dysdercus koenigii* Fabr. has been studied. The head is of prognathous type. Its dorsal surface is formed of the *vertex* and the *frontoclypeus*, the lateral walls of the two *genae*, and the ventral wall of a rectangular *"gula"* which continues anteriorly into a pair of maxillary plates.

The *frontoclypeus* bears a pair of clypeal folds which demarcate a central *anteclypeus* from the two lateral *paraclypeal* areas. The *maxillary plates* are demarcated from the *paraclypeal plates* by a pair of longitudinal maxillary folds. The ventral margin of the maxillary plates is produced into a ridge-like projection to form *bucculae*.

The usual tentorium is absent in this insect. The endoskeleton of the head consists of plate-like chitinous inflections from the *clypeal* and *maxillary* folds, which divide the head cavity into five compartments.

The *hypopharynx* is a conical lobe situated in between the maxillary plates and it bears a pair of backwardly directed chitinous apodemes and encloses a salivary syringe.

The bristle pouches are the cavities in between the hypopharynx and the maxillary plates.

The beak consists of a three jointed labium within which are lodged a pair of maxillary and a pair of mandibular styles.

The musculature of the antennae, labrum, salivary syringe, sucking pump, labium and stylets has also been described in the paper.

## (iv) *Arachnida.*

### 22. The ovarian diverticula of *Heterometrus* (*Palamnaeus*) *scaber.*

A. P. MATHEW, Trivandrum.

The appearance of the ovary in the various genera of the *Scorpionidae,* when the embryos have begun to develop, is strikingly different from the same in the other scorpions such as Buthids. Whereas in the latter the fertilised egg passes into the ovarian tubules so that as the embryos enlarge the ovary presents a beaded appearance, in the former the zygotes remain in the follicles which grow outwards in the form of characteristic diverticula as the embryo develops. Accompanying the growth of the embryo there are corresponding changes in these diverticula which are figured and described, correlating them with the developmental stages of the contained embryos. The oocytes are marked by mere swellings, which at the time of maturation of the eggs, grow out into finger shaped diverticula. These soon enlarge and by the time fertilisation takes place, a mass of cells at the distal end gives rise to the appendix a mechanism for the nourishment of the embryo which is developing out of a more or less yolkless egg. The internal changes in the diverticulum making it fit to accommodate the embryo and its corresponding external alterations of form are given, till the embryos are fully mature and ready to be born. After birth the empty diverticula remain attached to the ovarian tube and undergo gradual degeneration while a new series develops for the 2nd pregnancy. Vestiges of empty diverticula in different stages of degeneration enable us to find out how often a particular scorpion has been gravid.

### 23. New acaricides for the control of the vegetable mite—*Tetranychus telarius* Linn. (Acarina : Tetranychidae).

SARDAR SINGH *and* B. S. SAINI, Ludhiana.

The vegetable mite (*Tetranychus telarius* Linn.) has become a limiting factor in the economic production of Ladys' finger (*Abeimoschus esculentus* L.) in the vegetable belt around Ludhiana because of the continuous use of DDT suspension sprays for the control of the jassid—*Empoasca devastans* Dist. Apparently, the use of DDT has adversely affected the population of the parasites and predators of the vegetable mite.

Two new acaricides Akar 338 (Ethyl ester of 4-4 dichlorobenzilic acid) and Aramite 15.W. (2-P-tert butyl phenoxy isopropyl chloroethyl sulphite) were compared with Lime-sulphur compound and lime-sulphur dust at the Students' Farm of the Government Agricultural College, Ludhiana, during June-July, 1955. Wettable powders of Akar 338 and Aramite 15W were used in dilutions of 1 : 400 and 1 : 500 with water. The stock solution of lime-sulphur compound was diluted seven times and control plot was sprayed with simple water. There were three experiments and two replications in each experiment.

Akar 338 gave an average percentage mortality of 86·12, Aramite 15W, 86·41, Lime sulphur compound 72·14, Lime sulphur dust 64·07 compared to 11·2 in control. The mortalities in case the two dilutions of Akar 338 and Aramite 15W viz. 1 : 400 and 1 : 500 were practically the same. The adoption of these two acaricides is expected to find favour with the growers because of their greater efficacy and easy application.

## 24. A new species of myialgesid mite parasitic on *Pseudolynchia maura* (Diptera-Hippoboscidae) from India.

L. S. HIREGAUDAR, Bombay.

The members of the family Myialgesidae are parasitic on Hippoboscidae (Diptera) and Mallophaga. A new species, *Myialges indica* under this family has been described for the first time from India. *M. indica* bears a close resemblance to *M. caulotcon* but it differs from it in possessing the posterior border of the propodosomal plate rounded without any angles and in the shape of the distal segment of the tarsus of the 1st pair of legs modified like an anchor without any seta at its base. It also differs from *Myialgopsis trinotoni* in the absence of the ambulacral sucker on the 1st pair of legs.

### (v) *Mollusca.*

## 25. Chemical investigations on the formation of pearls in the Indian pearl oyster (*Margaritifera vulgaris*).

R. VENKATARAMAN *and* S. T. CHARI, Kozhikode.

An investigation was conducted on the Indian Pearl Oyster (*Margaritifera vulgaris*) during the recent pearl fishery conducted by the Madras Fisheries Department at Tuticorin (March to May 1955) as to the probable chemical causes that promote the formation of pearls in the oyster. For this purpose, samples of oyster flesh were collected from (1) those oysters that contained fairly good sized (pepper or pea-sized) pearls (2) those that contained seed pearls (small sized or mustard seed sized) and (3) those that did not contain any type of pearl. The samples were analysed for their moisture, Nitrogen, fat, ash, phosphorus, calcium and iron contents. The results show that there is no difference in the chemical composition of the three different categories of the oyster flesh.

The crude proteins obtained from the above three categories of samples, were also subjected to amino-acid composition determination by the circular paper chromatography technique using n-Butanol : Acetic Acid : Water (4 : 1 : 5) and the separable amino-acid groups quantitatively estimated. The amino-acid make-up of the three different varieties of samples also fail to show any characteristic differences to be of value in formulating the factors at work for the favourable formation of pearls in the bivalve.

### (vi) *Fishes and Fisheries.*

## 26. Survival of fry in some nurseries of Uttar Pradesh.

M. P. UPADHYAYA, Lucknow.

For the first time the survival of fry to fingerling stage in the nurseries of Uttar Pradesh has been reported under different hydrobiological conditions. The nine nurseries selected at Sultanpur varied in area from 0·11 to 1·5 acres. In U.P. fry appears in the first week of July and lasts upto the end of August. The fry, consisting mainly of *Labeo rohita, Cirrhina mrigala, Catla catla, Chela bacaila, Cirrhina reba, Labeo bata* etc., are collected by 'Jaunpur type' nets from nalas. 27, 25, 580 fry were stored in the nine nurseries out of which 3, 89, 199 fingerlings of *Labeo rohita, Cirrhina mrigala* and *Catla catla* were taken out, resulting in 14·2% survival. Samples of water and plankton were collected from time to time. Observations on colour (muddy, greenish or turbid), depth (2·5-17 ft.), turbidity (3-52 cm. Sechi's disc reading), temperature of water (65-94°F), atmosphere

(73-93°F) and pH (6·9-8·4) and determination in p.p.m. of carbon dioxide (0-21), dissolved oxygen (0·02-15·8), calcium (46-120 $CaCO_3$) and ammonia (0-86) were made in the case of water. The limiting values are given within brackets. The plankton consisted mainly of daphnia, cyclops, cerodaphnia, sida, euglena, moina etc. The aquatic life consisted of ranatra, beetles, eubranchipus. The growth of rohu, nain and catla under the above hydrobiological conditions was 1·04″, 0·9″ and 1·3″ per month respectively.

## 27. Growth environments of LaMartiniere college tank Lucknow.

M. P. UPADHYAYA, Lucknow.

In this paper the physico-chemical characters of water and chemical constituents of bottom soil of LaMartiniere College tank, Lucknow have been studied in relation to growth of fingerlings of *Labeo rohita* and *Cirrhina mrigala*. The growth of these fishes was 0·54″ and 1″ per month respectively. The growth of *Cirrhina mrigala* was good while that of *Labeo rohita* was poor. In case of water observations on colour, temperature of water (60-96°F) and atmosphere (63-96·8F), weather conditions and determinations in p.p.m. of dissolved solids (volatile 20-178·4; fixed 45·6-201·6; total 80·8-342), pH (7·1-9·0), carbon dioxide (0-15), dissolved oxygen (1·6-7·1), B.O.D. (1·1-12·7), Chlorides (1·5-12), Total hardness (10-256), and total ammonia (0·15-6·3 NH3) in p.p.m. were made. In case of bottom soil values for loss on ignition (2·4-12·2%), silica (83·06-92·2%), iron (2·4-16·6% Fe), calcium (0·48-2·55% Ca) and magnesium (0·11-2·37% Mg) were determined. The limiting values for each constituent are given within brackets. Some of the values are very high and these were generally found either during summer when there was great reduction in water level or during rainy season when lot of silt was brought by the rain water. The high values prove that major carps can live under these abnormal conditions also without any adverse effects on them.

## 28. Water and soil study of Garha tank Lucknow in relation to growth of fish.

M. P. UPADHYAYA, Lucknow.

Faruqi (P. I. S. C. 1951, 1953) studied the relative growth of *Labeo rohita*, *Cirrhina mrigala* and *Catla catla* and total fish yield from Garha tank, Lucknow. With a view to determine the factors responsible for good growth in this tank, the study of water and soil was also done. Conditions of this tank have been compared with those of LaMartiniere College tank (P.I.S.C. 1956) in which the growth was not satisfactory. Observation on colour, weather conditions, temperature of water (68-79°F) and atmosphere (64-90°F) and determinations in p.p.m. of solids (volatile 100·8-1668; fixed 112-612; total 388-2244) pH (7·7-8·5), carbon dioxide (0-12), dissolved oxygen (0·38-16), chlorides (58-363), total hardness (82-188), total ammonia (0-4·62), calcium (79·2-256·5) were done for water. Plankton residue varied between 0·2-3·2 cc. per litre and number of organisms between 51-1120 per 100 cc. of water. In all 70 species of phyto and zoo plankton were found. Values for loss on ignition (4·2-12·25%), silica (63·2-82·9%), iron (8·4-22·5% Fe) and calcium (0·83-2·75% Ca) were determined for soil. The growth of *Labeo rohita*, *Cirrhina mrigala* and *Catla catla* was 1·05″, 0·7″, 1·4″ per month (Faruqi P.I.S.C. 1951) and the maximum size attained in the first fifteen months was 19·5, 14·9, 24″ respectively. The stocked size being 3·7, 3·7, 4″. The causes of good growth in this tank are abundant availibility of food and high values for solids, carbon dioxide, dissolved oxygen, hardness, chlorides in case of water and iron and calcium in case of soil.

## 29. Water and soil study of Gomti river Lucknow.

M. P. Upadhyaya, Lucknow.

Study of the physics and chemistry of water of Gomti river in Lucknow city was done by Upadhyaya (P.I.S.C. 1947) and the work was continued from August 1946 to July 1947 along with the study of bottom soil. The fishes of economic value found in the river are *Labeo rohita, Cirrhina mrigala, Catla catla, Labeo calbasu, Notopterus notopterus, N. chitala, Ophicephalus punctatus, O. striatus, Bagarius bagarius, Clarias batrachus, Hetropneustes fossilis, Rita rita, Mystus aor. M. Singhala, M. vittatus, Wallogonia attu* etc. In the case of water observations on colour, weather conditions, temperature of water (59·5-90·5°F) and atmosphere (59-93°F) and determinations in p.p.m. of dissolved solids (volatile 50·4-96, fixed 38·4-304; total 96-400), chlorides (3-13), total hardness (15-303), pH (7·6-8·3), carbon dioxide (0-10), dissolved oxygen (2-5·6) B.O.D. (0·4-5·3) and ammonia (0·36-4·5) were made. For bottom soil loss on ignition (7·4-48·4% Ca) silica (81·03-99·8% $SiO_2$), Iron (2·5-8·5% Fe), calcium (0·56-1·72% Ca) and magnesium (0·07-1·78% Mg) were determined. The limiting values are given within brackets. The values for the water of Gomti river at Lucknow have been compared with those of the river at Sultan and Jaunpur and with those of Ganga at Banaras.

## 30. Nutritive value of major carps of U.P.

M. P. Upadhyaya, Lucknow.

The nutritive value of the four economic carps of Uttar Pradesh, viz. *Labeo rohita, Cirrhina mrigala, Catla catla* and *Labeo calbasu* has been determined for the first time. These fishes are being developed by the Fisheries Department of the State. Values for edible flesh, moisture, protein and ash have been reported and are given in the following table. When classified according to their protein content the order is *Cirrhina mrigala, Labeo calbasu, Catla catla* and *Labeo rohita.*

| Zoological name | No. of fish used | Length | Weight | Edible flesh % | moisture % | protein % | Ash % |
|---|---|---|---|---|---|---|---|
| *Cirrhina mrigala* ... | 1 | 16″ | 20 oz. | 46·5 | 76·97 | 16·8 | 1·25 |
| *Labeo calbasu* ... | 1 | 20″ | 48 oz. | 44·9 | 80·25 | 14·88 | 1·12 |
| *Catla catla* ... | 1 | 19·5″ | 64 oz. | 43·7 | 60·0 | 12·35 | 1·09 |
| *Labeo rohita* ... | 1 | 17″ & 19″ | 76 oz. | 36·8 | 82·3 | 10·74 | 1·02 |

## 31. A preliminary account of the fouling organisms of the Vizagapatam harbour area.

P. N. Ganapati, M. V. Lakshmana Rao *and* R. Nagabhushanam.

The paper embodies the result of one year's observation on fouling of submerged surfaces of test panels. Asbestos, wood and glass panels were periodically exposed to fouling by marine growth in three localities of the Vizagapatam harbour. Fifty-nine species of fouling organisms have been identified. The seasonal occurrence and rates of growth of some common forms have been studied.

The succession of fouling organisms at station B is outlined.

Differences in fouling at the three stations are attributed to the differences in the prevailing ecological conditions. Heavy fouling at station B was attributed to (1) alternate inundation of this station by fresh-sea-water and polluted waters rich in nutrients, (2) less disturbance by waves and tides and (3) its proximity to a place where heavily fouled boats are scraped.

There is difference both in quality and quantity of fouling in the local harbour as compared with Madras, the probable reasons for which have been discussed.

### 32. A hydrological and bacteriological investigation of a case of large scale fish mortality in a temple tank.

R. VENKATARAMAN, S. T. CHARI *and* A. SREENIVASAN, Kozhikode.

Large scale mortality of fish occurred in a temple tank in Sankaranainar Koil, in Ramnad District on more than one occasion. The physico-chemical and bacteriological conditions were investigated in detail by us on one occasion. Three species of fish which were stocked, viz. *Labeo, Cirrhina,* and *Barbus,* all succumbed in two to three days of stocking. The tank had an overgrowth of the blue green alga *Microcystis,* which formed a 'blanket' to a depth of 24". Though due to photosynthetic activities oxygen content was high during day time, it reached a critical value at night and the fish died due to anoxaemia. Neither $H_2S$ nor sugars were detected but putrefactive 'amine' odours were strong due to decay of algae. Probable toxic action of this alga is also discussed.

### 33. Further studies on red halophilic bacteria from salted fish and salts and description of new species.

R. VENKATARAMAN *and* A. SREENIVASAN, Kozhikode.

A large number of salt samples from various geographical areas have been examined for their content of red-halophilic bacteria. High counts of these organisms were related to the high Magnesium and Calcuim contents. The cocci consisted of *Micrococci* resembling *M. morhuae* and Sarcina species. The rod forms were of three types : 1. Very highly pleomorphic bizarre forms with simple rods, cuneate, fusiform, oval and spherical almost coccoid shapes, which appeared to be non-motile. 2. Minute, gram negative simple, motile rods without much of pleomorphism. 3. Gram negative, long filamentous, curved non-motile rods, not showing pleomorphism prominently. Some of the pleomorphic rods in group 1 appear to resemble *Pseudomonas Salinaria* and *Ps. cutirubra* but some are distinctly different in chromogenesis, in motility etc. Group 2 resemble *Bact. trapanicum* but flagellation may show the correct relationship. The third group has not hitherto been described by other workers and are presumed to be new species.

Most of these are obligately halophilic and very few grew on 10% NaCl agar and if at all they grew it was scanty and delayed. Growth was either absent or scanty in broths. Staining was very difficult since the usual methods of staining resulted in plasmoptysis. The cocci were gram positive but the rods gram negative. Even 10% NaCl caused the bursting of rods (though not of cocci). Smears were hence prepared with 20% NaCl and fixed with methyl alcohol and stained. Contrary to the notion that the peculiar pleomorphic shapes were due to heat fixation, and staining, we noted pleomorphism even in 48 hour old cultures in hanging drops with 20% NaCl.

### 34. Investigations on the quality of salted fish sold in the markets.

R. VENKATARAMAN *and* A. G. VASAVAN, Kozhikode.

Properly salted fish should remain in good condition for at least three months. But most of the salted fish available in our markets falls short of this standard because of the inefficiency of curing.

To investigate this representative samples of salted fish were collected from two markets in Kozhikode town. The quality was examined, by an analysis for moisture, salt and T. V. B. (Total Volatile Bases) and organoleptic tests. The collected samples were kept under observation and it was observed that most of the samples went bad within two months due to red attack and decomposition. The major defect in most of the cases studied was insufficient drying.

To remedy this better initial drying as well as periodic drying of the fish stored in godowns, if possible is suggested. The beach drying (without application of salt) of small fishes like white bait is found to be a poor method of preserving them.

## 35. Pituitary structure in relation to spawning of food fish.

B. I. Sundararaj *and* L. S. Ramaswami, Bangalore.

Food fish like carps do not breed in confined waters and the environmental factors do not appear to be responsible in making these fish spawn. The endocrine secretion is probably solely responsible for ovulation and dehiscence. So, an attempt is made to study the correlation that exists between the pituitary and the development of gonads in *Saccobranchus* and *Ophicephalus* by making an annual collection of these species from a local tank. Hydrological data are also collected.

The fish pituitary does not show marked divisions of the adenohypophysis. However, the three regions can be easily recognised. During the month of February the pituitary showed large number of acidophils and a few basophils. The ovary had ova in different stages of growth. In March and April as the ova underwent further development the number of basophils in the pituitary was large. In June, July and August the ovary is laden with large ova and the pituitary showed very large number of basophils thereby showing the relation between the two.

*Saccobranchus* has been induced to spawn in the laboratory by injecting graded doses of Saccobranchus pituitary.

The seminal vesicles have been noticed in the male specimens of Saccorbranchus and it stores no active sperms.

## 36. The Development of the Chondrocranium in the Indian Sea-horse, *Hippocampus* (*Lophobranchii*).

K. M. Kadam, Bangalore.

A study of the development of the sea-horse reveals certain interesting features which are no doubt associated with the curious shape of the head, the long snout and the small suctorial mouth. The development has been studied in 9 mm., 12 mm., and 18 mm. stages. The striking feature of the chondrocranium is the marked elongation of the anterior region of it, the ethmoid plate and the hyosymplectic being the most affected. Further, there is a peculiar modification of the ethmoid plate. The anterior portion of the ethmoid plate is not only bent upwards but also backwards in the 9 mm. stage. A gradual straightening of this region is noticed in the later stages of development. The nasal region has a well defined nasal septum from the early stages and is not independent from the ethmoid plate as in *Syngnathus* (Kindred 1921). A lamina orbitonasalis and sphenoseptal commissure are present. The orbital cartilages are reduced. In the auditory capsule the cartilaginous septae are vestigeal. A tectum synotimum is present as a rudimentary cartilaginous rod. A tectum posterius connects the occipital arches in the posterior region. A lateral commissure and a pila lateralis are present.

The pterygoid process of the quadrate has an 'acrartete' type of attachment with the preethmoid cornu of the ethmoid plate. The quadrate is in cartilaginous continuity with Meckel's cartilage in the 9 mmfi stage. In the same stage Meckel's cartilages are vertical and in later stages assume the normal horizontal position. A well developed rostral cartilage is present.

## 37. Cranial Osteology of Catfishes.

### Part 1. *The development of chondrocranium in three members,—Silonia, Pangasius and Ailia of the family Schilbeidae.*

H. R. SRINIVASACHAR, Bangalore.

A study of the development of the chondrocranium in *Silonia Pangasius* and *Ailia* belonging to the family—Schilbeidae is undertaken as the first part in a series of studies on the Cranial osteology of Catfishes. The development of chondrocranium in *Silonia* is studied from series of stages ranging from 8 mm. to 23 mm. and compared with the chondrocrania of *Pangasius* and *Ailia* in order to find out whether these characters throw any light on the systematics of the family.

In the 8 mm. stage of *Silonia* the chondrocranium is elongated and does not possess a roofing cartilage as observed in the 10 mm. stage of *Amiurus* (Kindred 1919). The hypophysial fenestra is large and is almost equal in length to the basal plate. There are no basicapsular and basicranial fenestrae. The trigeminal and facial nerves pass through a wide foramen in front of the auditory capsules between the orbital cartilage and trabeculae of each side. In the visceral skeleton the pterygoid process chondrifies independently and is in the form of a small rod on either side of the ethmoid region. The quadrate is fused with hyomandibula. All the five branchial arches are developed. The hypohyals project anteriorly to the copula.

The chondrocranium is fully formed in the 23 mm. stage and is wide in the region of the auditory capsule. A lamina precerebralis forming the anterior boundary for the cranium is developed and does not extend posteriorly. This lamina is virtually the nasal septum broadened anteriorly. The orbital cartilages are stout and are not connected by a complete epiphysial bar. The auditory capsules are connected dorsally in the posterior region of the occipital arch. There is no interorbital septum and the chondrocranium is therefore platytrabic.

The hyomandibularis branch of the facial nerve passes through a niche in front of the hyomandibular cartilage, but appears to be enclosed by bone in later stages.

The chondrocranium of *Pangasius* is very much similar to the chondrocranium of *Silonia*. But in *Pangasius* a small basicapsular fenestra is seen in the posterior region of the floor of the basal plate. An epiphysial bar is noticed connecting the two orbital cartilages.

In the chondrocranium of *Ailia* many interesting features are noticed. The chondrocranium is elongated. In the ethmoid region, a nasal septum is developed extending posteriorly and the roof for the olfactory lobes is reduced. A complete epiphysial bar is noticed as in *Pangasius*. Labial cartilages supporting the maxillary and mandibular barbels are developed in the fully formed chondrocranium.

The interrelationship between these members are discussed in the paper.

## (vii) *Reptilia.*

## 38. On the distribution of reptiles in the desert of Rajasthan.

DAYA KRISHNA *and* K. C. DAVE, Jodhpur.

Blanford (1901) and Mahendra (1931) divided India into 5, and 10 subregions respectively and the Indian desert was placed in "The arid and semi-arid province of Northwestern India". However, for the present study the desert of Rajasthan has been divided in three subregions according to the climatological data and occurrence of reptiles. Lizards and snakes collected from each area are noted against them. We do not, however, rule out the possibility of their existence in the other subregions as well. *Uromastix, Agama, Hemidactylus, Calotes, Varanus monitor, Mabuya, Eryx johnii, Zamenis, Naia tripudian, Bungarus coeruleus* and *Echis carinata* are common to all the subregions.

Arid subregion :—Rainfall 5". North-western portion of Jaisalmer district : *Stenodactylus, Gymnodactylus, Hemidactylus leschlaunti, Eublepharus, Acanthodactylus, Ophiomorus tridactylus, Eryx conicus, Coluber helena, Bungarus coeruleus* sbsp. nov., and *Eristrocophis macmohani.*

Semi-arid subregion :—Rainfall 5 to 10". Central desert : *Alsophylax tuberculatus, Stenodactylus, Gymnodactylus, Hemidactylus brooki, Agama, Mabuya, Ophiomorus, Diosas, Psammophis,* and *Varanus griseus.*

Sub-humid subregion :—Rainfall 10-15" South-east Barmer, North-east Jodhpur, Ganganagar, Sikar and Jhunjhunu districts : *Calotis, Chameleon, Mabuya dissimilis, Varanus monitor* etc.

New species of *Varanus griseus* and *Bungarus coeruleus* have been described.

The study was carried out with the financial help from U.N.E.S.C.O. and we are grateful to the Organisation.

## 39. Observations on the food and feeding habits of *Uromastix hardwickii* Gray.

DAYA KRISHNA *and* K. C. DAVE, Jodhpur.

The lizards, *Uromastix hardwickii* were collected from Gadra Road, Jaisalmer, Phalodi and Bikaner. Care was taken to capture them just after their feeding time. Their stomachs were examined. The contents consisted of plant material only. Most of them were the particular plants *Trianthema monogyna* Linn., and *Eragrostis* sp., especially from the specimens collected from Gadra Road and Phalodi and *Cenchrus catharticus* DC from Bikaner.

Certain experiments were also carried out in semi-captive and captive conditions to ascertain their preference and choice of food. The lizards were kept in large cages which had thick layer of sand at their bottom, in which the *Uromastix* could dig their burrows. Insects, flesh of animals, plants and grasses, vegetables, seeds and grains were given to them in various combinations and also separately. A series of experiments showed that *U. hardwickii* is herbivorous and prefers *Pennisetum typhoidum* and *Eragrostis* sp. They were never observed to drink water in captivity, although it was always available. In nature, however, water is not available in the vicinity of 2 to 5 miles from their habitat. Moreover their home range is only 100 yards from their burrows.

## 40. Neurosecretory cells of the brain of the garden lizard *Calotes versicolor* (Daud).

K. K. NAYAR *and* V. ANANTHANARAYANAN, Trivandrum.

This paper deals with the neurosecretory cells in the brain of the garden lizard Calotes versicolor. Here in the hypothalamus there are two concentrations of glandular neurons, the para ventricular nucleus and the supra-optic nucleus. The former is located on either side of the diacoel and the latter just above the optic tract. The hormones produced by the cells of these nuclei pass along their long axons through the infundibular stalk to the neural lobe of the hypophysis, from where they diffuse into the blood stream. Another pathway exists from the para ventricular nucleus to the Commissura Pallii posterior and the paraphysis. The secretory cells are characteristic and are easily distinguishable from other neurons by their large size, large nucleus, prominent nucleolus and characteristic staining reactions. The Cytoplasmic granules stain dark blue with Gomori's Chrome-Alum Haematoxylin. The examination of live cells reveal the occurrence of numerous spheroids in the cytoplasm which remain mostly connected together as clumps or chains.

## 41. Age changes of the thymus of *Calotes versicolor* (Daud) as correlated with testicular changes.

M. Appaswamy Rao, Bangalore.

A study of the thymus and testis of *Calotes versicolor* in juveniles and adults during breeding and non-breeding seasons, indicates an interesting relationship between these two organs. In juvenile animals the thymus is compact. With the increase in the mitotic activity of the spermatogonial cells of the testis, there is hyperplasia of the medulla with an enormous increase in the number of unicellular Hassall's corpuscles. In the breeding season the thymus undergoes involution, while in the non-breeding season, when the testis regresses, the thymus regenerates.

In animals which pass through the first sex cycle (Body weight 2 to 45 grams —Group 1) and in those which have had large number of breeding and non-breeding seasons (Body weight 67 to 88 grams—Group 3), the involution of the thymus is not of the acute type wherein there is infiltration of connective tissue into the parenchyma of the gland. The interstitial cells of the testis in these animals are smaller in size and fewer in number. In animals which have passed through only one or two sex cycles (Body weight=52 to 60 grams—Group 2), the thymus undergoes an acute involution resulting in the formation of spheroidal or ovoidal cavities filled with degenerating plasmodial masses and unicellular corpuscles. At this stage it is interesting to note that the interstitial cells are large in number and size. It is suggested that the intensity of involution of the thymus depends upon the production of the hormone of the interstitial cells (Testosterone), thus indicating a direct relationship between the testis and thymus.

There is a close correlation between the spermatogenic activity of the testis and the formation of the unicellular Hassall's corpuscles. In all the three groups, whenever the mitotic activity of the spermatogonial cells is great, there will be the maximum number of unicellular corpuscles in the thymus. As a matter of fact the entire gland is packed with these large cells. It is rather difficult at this stage, to bring out any functional correlation between the formation of these corpuscles and the spermatogenesis of the testis. It is suggested that the follicular stimulating hormone (FSH) of the pituitary which astivates the spermatogonial cells may stimulate the thymus in the production of these unicellular corpuscles.

the maxil-
ndrocranium.
the paper.

## 42. The Osteology of the lizard *Ophiomorus tridactylus*

M. S. Rathore, Jodhpur.

In this paper the author deals with a detailed accou asthan.
(excluding the skull) of Ophiomorus tridactylus Blyth, b
skeletons prepared by macertion and Alizarine methods. ur.

The vertebrae are procoelous, without intervertebra o 5, and 10 subregions
cervical ribs is carried by the fourth cervical vertebra and semi-arid province

sacral vertebrae. Chevron bones are intercentrally arranged. Autotomy takes place intravertebrally and the two separating parts, i.e. anterior smaller and posterior bigger fit telescopically without any cartilaginous septum in between them.

Besides the usual, abdominal ribs, small rib-like pieces, regularly arranged on the ventral side of the entire abdomen, are also present.

Scapula and Coracoid are completely fused into a single bone, and the epicoracoids mesially separate from each other. Two pairs of ribs are attached to the single fenestrated cartilaginous sternum, and one pair to the non-fenestrated and triradiate Xiphisternum. Clavicles are non-fenestrated, and each of them extends to meet the suprascapula. The inter-clavicle is cruciform. In the pelvic-girdle a round bony epipubis and a rod-like hypoischium are present. The limbs are tridactylus. The fourth and fifth digits are absent.

## 43. The Cranial Osteology of the Lizard *Ophiomorus tridactylus* Blyth.

M. S. Rathore, Jodhpur.

The skull is streptostylic, diapsid and amphikinetic. The occipital bones are distinct but compactly joined, and the occipital condyle is tripartite. Opisthotic is fused with the exoccipital, and the former and the prootic contribute equally to the formation of fenestra ovalis, which is covered by the stapedial plate to which a reduced knob like columella-auris is fused. Recesses of the three semicircular canals can be distinctly made out on the dorsal side of the supraoccipital, opisthotic and prootic bones. The fused parietals have a pineal foramen in the centre. The processus descendens of parietals extend ventrally and meet the epipterygoid of their side. The latter fits ventrally in to a pocket on the quadrate part of the pterygoid The quadrate is compact and triradiate. The small supra-temporal fossa is separated from the very big lateral temporal fossa by the supra-temporal arcade. It is composed of squamosal and post-orbital. The post and pre-frontals, the jugals and the lacrymals are present. Nasals and frontals are separate. The premaxillae are fused at their tips, but their processus nasalis are only joined. The pterygoid process of the basi-sphenoid joins the pterygoid with the cartilaginous meniscus. A cartilaginous parasphenoid runs upto the base of the canalis olfactorius, and rudiments of orbitosphenoids are present in the surrounding membranes. Dentition is pleurodont. The pterygoidal teeth are present. There is no pterygo pre-vomarine contact due to the intervention of palatines. They themselves are separated at the mid ventral line. The prevomers are united and form a part of the boundry of Jacobson's foramina and choanae.

Each ramus of the mandible is composed of six separate bones : articular-supra-angular, coronary, angular, splenial and dentary. The corpus of the hyoid carries a well developed processus entoglossus anteriorly below the tongue and postero laterally a hyoid arch, first certo branchial and first and second epibranchials.

## 40. Neurosecret
*color* (D

K. K. Naya

This paper deals
lizard Calotes versicolo
of glandular neurons,
The former is located
optic tract. The hormones
long axons through the i

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## (viii) *Mammalia.*

## Ecology and Distribution of the mammals of the Desert an.

Krishna *and* Ishwar Prakash, Jodhpur.

of mammals was collected all the year round from different egion of Rajasthan. The boundaries of the desert area have an earlier communication. In all, about 450 specimens r. These belong to about thirty species. The description of each species and sub-species deals with its synonyms, local name, size of adult male, female and juvenile. The colour of the animals has been discussed in detail to facilitate their identification. Skull measurements and lengths of their alimentary canal are also given. Under the head "Ecology" we have dealt with the habitat or the place of collection, their stomach contents, breeding records and Ecto- and Endo-parasites. The distribution of mammals in the desert of Rajasthan and in India is also dealt with.

The paper also records a comparison of these mammals with those of the adjacent fertile areas and also with those found in other desert regions of the world.

A key to identify the mammals found in this area is also given as an Appendix to the paper.

This study has been financed by UNESCO and we are grateful to that Organisation.

## 45. A preliminary study on the conservation of the Great One-horned Rhinoceros in the Kaziranga Wild Life Sanctury, Sibsagar District, Assam.

H. KHAJURIA, Calcutta.

The importance of wild life conservation in India needs no emphasis at present. The present investigation is a preliminary attempt on such a study and was carried out from 9th to 31st March, 1955. It is proposed to continue these observations as and when opportunities occur.

Due to the presence of very luxuriant and 15-20 ft. tall elephant grass, the whole investigation was carried out on an elephant back. The census was taken by examining a number of population samples from different parts of the sanctuary. Two more methods, named as 'Rhino Dung-head' and 'Burnt Grass' methods, of taking census were also discovered but were not used for want of time and suitable facilities. The problems found to need urgent attention are: (1) silting of 'bhils' by water hyacinth and floods; (2) insufficiency of certain grasses much liked by the rhinoceros; (3) grazing inside the sanctuary of diseased cattle; (4) presence of a large number of uneducated persons very near the boundaries of the sanctuary; and (5) the overcrowding which may be caused by the increasing hog-deer population.

## 46. Ecological studies on the bats of the desert of Rajasthan.

DAYA KRISHNA, ISHWAR PRAKASH *and* S. C. SHARMA, Jodhpur.

The Chiropterous, except *Pteropus giganteus giganteus,* inhabit dark unattended ruins and caves. In Jodhpur, so far we have come across half a dozen such localities where the bats live in thousands and about a dozen such where they are only in hundreds. Most of the observations were taken at Mandore, a place six miles away from Jodhpur. Here they live in a tunnel about 500 ft. long, passing underneath a palace. The tunnel is inhabited by four species of bats. *Megaderma lyra lyra* live in the most interior darkest parts. Others, *Rhinopoma k. kinneari, R. kinneari* subsp. nov. and *Taphozous sp.* live in the outer parts with sufficient light. *Taphozous kachhensis kachhensis* has been observed to reside in the crevices of the rocks. *Rhinopoma hardwickii* live in the verandah of deserted buildings. They are not so common as others.

The paper also deals, in detail, with the amendments in Wroughton's Keys for the identification of bats, with their seasonal migrations, with their stomach contents and lastly with their breeding records.

## 47. A new genus and species of Indian Chiroptera.

H. KHAJURIA, Calcutta.

As the discovery of new mammals even at subspecific level is fast becoming a rarity, the present report dealing with a new genus will certainly be received with great interest. The specimen upon which the new genus is based was sent to the Museum of Comparative Zoology at Harvard College, Cambridge, Mass., U.S.A. for opinions but the museum experts could not offer any remarks on the identity of the specimen. The genus is allied to the American Vespertilionid genus *Lasiurus* Gray from which, however, it differs markedly in the characters of metacarpals, teeth, and the interfemoral membrane. An attempt is being made to collect more specimens for the purpose of undertaking a detailed study. As the nearest ally of the genus is known only from the New World, a better knowledge of its distribution is likely to be of considerable zoo-geographical interest.

## 48. Thymic changes in *Loris lydekkerianus* (Cabr.) during pregnancy and lactation.

B. A. GULAM AHMAD *and* M. APPASWAMY RAO, Bangalore.

A study of the thymus of juvenile (body weight—17 grams), pregnant (body weight—345 grams) and lactating female (body weight—244 grams) *Loris lydekkerianus* was made. In juvenile animals the thymus is large and lobulated giving off cervical extensions. Each lobule, which is enclosed in a thin compact capsular wall, exhibits a clear demarcation between cortex and medulla. In pregnant females the thoracic thymus is large, whereas its cervical extensions have undergone complete involution. Each lobule of the thoracic thymus has a thick capsular wall and the demarcation between cortex and medulla is not clear. In the lactating female the thymus has undergone complete involution. The entire thymus consists of a network of connective tissue with scattered patches of thymocytes. It is suggested that the presence of a well developed thoracic thymus may be due to the production STH and its involution in lactating female is caused by the prolactin hormone.

## 49. Food preferences of the desert hedgehog, *Hemiechinus auritus collaris* Gray.

DAYA KRISHNA *and* ISHWAR PRAKASH, Jodhpur.

In a previous communication (Krishna and Prakash, 1955) we have dealt with the food and feeding habits of the hedgehogs, *Hemiechinus auritus collaris* and *Paraechinus micropus micropus* Blyth. They are conservative in their habits, the former is more and was taken for detailed investigation. To find out its preference of food, it was provided with a wide variety of insects and birds. In a series of experiments entire birds and their flesh (of about 25 types) was provided to eight hedgehogs in separate cages. Each experiment was repeated several times placing the food material on the either side of the animal. This minimised the error due to the factor of availability. Experiments were also repeated with the hedgehogs under starvation. In order to explain clearly how the experiments were conducted, one is cited.

Expt. 146.

Flesh of birds; *Molpastes leucogenys* (1); *Molapastes cafer* (2); *Streptopelia risoria* (3); *Psittacula krameri* (4). Hedgehog "P".—On admission to the feeding chamber, "P" rushed to (4) smelt; passed on to (2), smelt and waited; reached (3), paid no attention; smelt (1), began eating, finished it; smelt (3), and (4) and ate (2) then took to (3) and lastly the (4).

For the tabulation of the experimental data the method of Cott (1951) was followed. Arrow point towards the preferred food material.

| Expt. No. | Animal | Food | Bird species provided | |
|---|---|---|---|---|
| 133 | Hedgehog "P" | entire birds | S. risoria | ←——M. leucogenys |
| | | | M. leucogenys | ——→S. risoria |
| | | | S. risoria | ←——P. krameri |
| | | | P. krameri | ——→S. risoria |
| | | | M. leucogenys | ——→P. krameri |
| | | | P. krameri | ←——M. leucogenys |

To confirm the consistency of the preference, certain overlapping experiments were also designed. If the bird A or its flesh is prefered over the bird B; and B over C then theoretically A should also be prefered over C. Similarly if a species D is rated below C; then both A and B should be prefered over D. When combination were tried, the preference was generally consistent with the theoretical conclusions, but in certain cases diversion was also observed.

*Streptopelia risoria* (A) ————————————————
*Molpastes leucogenys* (B) ————————————————
*Molpastes cafer* (C) ————————————————
*Psittacula krameri* (D) ————————————————
Expt. Theory "P" overlapping

Preferences of the hedgehogs are also correlated with the size, colour and food of the birds.

## Section VIII, Anthropology and Archaeology.

### 1. The Ethnological significance of Taste.

G. R. GAYRE, Saugor.

A survey of the ability to taste or not taste substances such as phenylthiourea or phenylthiocarbamide, usually called PTC, has been shown to be widespread and to have ethnological correlations.

From a survey of the evidence (which is given at length in the paper), the author rejects polymorphism as the basis for the distribution of tasting and non-tasting ability in the three primary racial stocks (Caucasoids, Mongoloids and Melanoids), and accounts for any apparent polymorphism as due to racial crossing.

He concludes that non-tasting is a characteristic mainly or partially developed in the Caucasoids, whereas inherently, it is not characteristic of the Mongoloids and Negroids and where it occurs it is due to cross-breeding with the Caucasoids.

## 2. The Changing Position of Women in India and North-South Polarization.

U. R. EHRENFELS, Madras.

A polarization of North and South in India corresponds to a certain degree with present or past distribution of *patri-* and *matri-lineal* societies. Such differences are illustrated by legal changes, contemplated to increase rights and status of women in the former, but have been revealed to inculcate curtailments of such rights of women in the latter, *i.e.*, matrilineal societies. This shows a shift of popular values, among patrilineal groups, towards a more "maternal" concept of society in contents, if not in name. The attempt to conceive this movement as a trend towards increased individualism only, superseding collectivism, encounters the difficulty that though it may explain (a) disintegration of the *patri-* as well as *matri-lineal* joint family, it fails to account for, (b) the difference, in this respect, of North- and South India.

Could North-South polarization, which is characteristic of the Indian situation, thus be interpreted in terms of *matrilineal* prepondertnce in the South? This interpretation, however, can hardly account for North-South polarization in other countries, where a similar culture-historic situation is not always in evidence (*cf.* : U.S.A., Ireland, England, Scandinavia, Russia, China, Arabia, Italy, Spain, France, Germany etc.). Causes for this polarization are examined (*Cf.* : (a) climate, proximity to, (b) pole or equator, (c) mountains or plains, (d) diffusion centres of conquerors and (e) of religious movements). None of these, however, can explain the uniformity of popular judgments and folk-attitudes, which Northerners show in different countries, towards Southerners and *vice-versa*. This polarization is not found in towns, though occasionally in small areas (Malabar, Ceylon, Albania ?) and is finally compared to attitudes of *moieties* or *phratries* in dual organization.

## Section IX, Medical and Veterinary Sciences.

### 1. "Transplantation of Fertilized Ova."

M. K. SHAH, Anand, Bombay.

In general, the present procedure of egg transplantation is to sacrifice a superovulated donor female to collect numerous fertilized ova by flushing its Fallopian tubes or the uterus using a suitable medium such as blood serum, and to transfer the eggs to the Fallopian tubes or the uterus as the case may be, of a laparotomized foster mother. Such transplantations have been successful in laboratory animals as well as farm animals including sheep and cattle. In cattle, simple non-surgical method of transplanting eggs to the uterus via the vagina and the cervix has met with failures because of the ease with which the recipient's uterus becomes susceptible to infection in the presence of an active corpus luteum secreting the hormone progesterone which on the other hand is so indispensable for the preparation of the uterus to allow implantation of the embryo.

In the experiments which was carried out at the University of Queensland, Australia, a technique was developed to transfer 6-day rabbit eggs to the uterus via the cervix through an incision in the vagina of 6-day pseudopregnant recipient after performing a laparotomy. Early attempts at such transfers failed, as they were generally followed by severe pyometra due to active corpora lutea of the pseudopregnant foster mothers. Unsuccessful attempts were also made to prevent introduction of infection into the uterus, by irrigating the vaginal canal by Zephiran solution for a few days prior to transplantation. Successful procedure by which about 37% of blastocysts transferred to the uterus via the cervix developed to term, involved the use of antibiotics. Pyometra which would generally ensue the transfer of eggs via the cervix in pseudopregnant rabbits, was obviated in this procedure by the local use of aureomycin and intramascular injections of penicillin. These results may be useful for further attempts at non-surgical transplantations of fertilized bovine ova via the cervix.

## 2. A clinical study of Incidence of Hypertension in the population of Dayalbagh (Agra).

K. N. GOUR *and* G. P. DUTTA, Agra.

The present work was undertaken :—

(*b*) To assess the incidence of hypertension in the population of Dayalbagh. (Agra) in various age groups in both sexes.

(*b*) To asesss the incidence of hypertension in the population of Dayalbagh.

(*c*) To assess the role of some aetiological factors like age, sex, heredity, occupation, diet and psychic factors in the causation of hypertension.

The available literature on the history of hypertension has been reviewed and material and methods described. The blood pressure estimations were done of 5,503 inhabitants of Dayalbagh, the blood pressure levels in different age groups in both sexes have been noted and mean average blood pressure level for each age group has been calculated.

Out of a population of 5,503 persons, 35 persons (0·7%) were found to be hypertensive. A detailed clinical and laboratory examination of these cases was done. They were thoroughly investigated on the lines noted before.

On the basis of the findings of these hypertensive cases, the role of age, sex, occupation, familial background, diet, constitution peculiarities and psychic factors in the production of hypertension in the population of Dayalbagh has been discussed in the light of the findings of other workers.

## 3. Incidence of Atherosclerosis in Relation to Hypertension in the village Population and an Experimental study of their relationship in the chick.

K. N. GOUR *and* R. C. GARG, Agra.

Atherosclerosis and Hypertension are a leading cause of death in the civilised world. Their close relationship i.e. hypertensive patients usually succumbing to coronary and cerebral atheroscierosis and atherosclerotic patients manifesting a raised blood pressure, is too well known. Besides causing the death of many millions, this combination incapacitates many more. Thus the problem has important physio-socio-economic facets.

There is an extensive lack of data about the incidence of atherosclersosis in this country, therefore this study was planned as an ethnopathological, biochemical and experimental study—a clinical study in the village population and an experimental study in the chick.

A study of 5,000 individuals in the rural population has shown 0·24% and 0·16% are suffering from atherosclerosis and hypertension respectively. The incidence is maximum from 40 to 60 years and is higher in males. The incidence is equal in the Hindus and the Muslims and higher in the Christians and in those engaged in sedentery occupations. It rises with the rise in economic status and is greater in Vegetarians on a high fat diet. Heredity, mental strain and habits, etc. play an insignificant role. Whereas 37·5% cases of hypertension, atherosclerosis was present, hypertension was found in 25% cases.

Experimental study in the chick has revealed that hypertension per se does not induce atherogenesis, but associated with disordered lipid metabolism, it intensifies and aggravates atherogenesis.

### 4. Role of Dietary Fats in the Pathogenesis of Atherosclerosis: An experimental study in the chick.

K. N. GOUR *and* S. D. TAYAL, Agra.

The study was undertaken to assess the role of dietary fats in the pathogenesis of atherosclerosis. Six chicks were taken for the animal experiments. They were fed on six different diet, the fat and cholesterol content of each being regulated. A record of each as regards its weight, growth, skeletal changes and blood biochemistry (plasma cholesterol and plasma lipid phosphorous) was kept. Skiagrams and photographs were taken from time to time. Autopsy was performed after 13 weeks of study. A complete gross and microscopic examination of the heart and blood vessels was done. Photographs of gross lesions as well as photomicrographs were taken.

These experiments point to a direct correlation between the dietary cholesterol intake and the genesis of atherosclerotic lesions under the circumstances, and the exogenous and endogenous factors were found capable of modifying the dietary influences in the pathogenesis of these lesions.

## Section X, Agricultural Sciences.

### 1. Growth Studies on and Nutrient uptake by Cigar Tobacco.

#### I. *Growth characteristics of cigar tobacco.*

K. G. TEJWANI, C. K. RAMAKRISHNA KURUP *and* K. V. VENKATRAMAN.

Growth characteristics of the cigar tobacco as grown in South India have been studied by observing the green and dry weight of the plant, height of stalk, emergence of new leaves and leaf area. It is observed that the growth period may be divided into four phases, which may be called the 1. 'Establishment' (3 weeks), 2. 'Transitional' (3 weeks), 3. 'Active' (4 weeks) and 4. 'Maturation' (3 weeks) phases of growth. The 'Active' phase of growth is the most important from the point of yield. The rate of expansion of the leaf area and accumulation of dry matter of the whole plant and the leaves is maximum during the second phase, and that by the stalk during the third phase.

### 2. Land use policy.

BISHAN MANSINGH.

Best use of land may be defined as that use, under which the land produces most and deteriorates least.

This object can be achieved if different kinds of soils are classified according to their suitability for different kinds of land use, viz., cultivation, grazing lands and afforestation.

Measures to stop deterioration of soil should be given first priority. One of the most important of these measures is Flood Control on scientific lines, for example, holding a rain water near the place where it falls and the utilisation of surplus water for the benefit of crops, pastures and trees.

For the success of this campaign a vigorous and effective education programme should be organized to acquaint the masses with the evil effects of erosion, which is bound to increase in the absence of proper land use.

### 3. "Systematic investigation of Soil organic matter Part IV. Identification of anino-acids in the hematomelanic acid fraction."

NEWTON RAM *and* ABANI K. BHATTACHARYA, Agra College, Agra.

Several samples of Agra Soil were hydrolysed with semi-normal caustic soda. The filtrate obtained from this was treated with dilute sulphuric acid. The humic acid thus precipitated was separated and soxhletised with alcohol for six hours. The alcoholic extract containing hematomelanic acid was evaporated and the residue was further soxhletised with benzene for six hours. The insoluble fraction was hydrolysed with semi-normal hydrochloric acid and filtered. The filtrate was evaporated under reduced pressure to remove excess of hydrochloric acid and the residue was treated with absolute alcohol. The alcoholic solution containing the amino-acids was subjected to paper chromatography.

The following amino-acids were identified both by ascending and descending methods of paper chromatography.

Aspartic acid, Arginine, Histidine, Valine, Isoleucine, Leucine and Methionine.

It appears that there is a great similarity between the proteins of the soil in the temperate and the tropical zones and this will be further elucidated by examining other fractions of the Agra Soil hydrolysates in due course of time.

## 4. Soil survey and soil classification in India with special reference to forest conditions.

RAGHUNATH S. GUPTA, Dehra Dun.

Author has discussed the different attempts made at soil classification for India as a whole and in different States by different departments. Soil maps prepared by Dr. Viswanath, under All India Soil Survey Scheme by Dr. Raychaudhuri with an agricultural bias, and Prof. Champion from forestry point of views giving the different types are also discussed.

A broad grouping of soils is suggested by the author as follows :

SOIL GROUPS OF INDIA.

| 66 | I | |
|---|---|---|
| *Himalayan and the Siwalik regions.*<br>Soil formed from sedimentary and metamorphic rocks (such as phyllitic, quartzite, biotite etc.) under temperate climatic conditions in respect of temperature, but rainfall distribution between temperate and tropical conditions differ. | *Indo-Gangetic Aluvium*<br>Parent material cannot be traced as these are alluvial or aeolian in nature. | *Deccan plateaux.*<br>*Soils* formed from mainly igneous rocks (granites, gneiss, charnokite etc.) under truly humid tropical conditions. |
| 1. Podsols mainly under conifers. | 1. Deltaic alluvium. | 1. Red soils. |
| 2. Brown forest soils Brown earths. | 2. Desert deposits (Pure sand dunes, Sand dunes and rock hills. Stabilised sands). | 2. Laterite soil. |
| | 3. Sub-recent formation (Bhabar and Tarai). | 3. Black cotton soils. |
| | 4. Saline (Solonchak) soil and alkaline (Solonetz) soil. | |
| | 5. Yellow and brown soils. | |

Since different maps prepared so far are either from an agricultural or forestry point of view, a study is suggested under a centralized agency consisting of agriculturists, foresters and geologists so that attempts made so far at producing a soil map by different departments could be co-ordinated.

## 5. A short note on effect of *p*H on the retting period of Jute.

A. K. KUNDU *and* G. HALDER, Barrackpore.

Retting is essentially a micro-biological process. pH plays an important role in the activity of micro-organisms. In the laboratory scale experiments, it was found that pH considerably affects the retting period. The period is the lowest at pH *c* 3·0 and with the rise of pH the retting period increases and at pH *c* 7·0 the time taken for retting is lower than at pH values above or below it. This shows that there are distinctly two types of organisms which rets jute.

## 6. Parasitisation in the egg masses of the various broods of Scirpophaga nivella Fabr.

M. Q. KHAN *and* B. H. K. MURTHY RAO.

The egg masses of Scirpophaga nivella Fabr. is parasitised by Telenomus beneficiens and Tetrastichus Sp. Of the two only Telenomus beneficiens has been observed to occur in Hyderabad State. A review of the relevant literature has revealed that parasitisation study brood-wise has not been made any where so far in India. An attempt is made in this paper to assess brood-wise (1) The percentage of parasitisation of egg masses, (2) Number of parasites emerging per partial and fully parasitised egg mass and (3) Number of larvae emerging per partial and completely healthy egg mass.

## 7. Longevity and rate of reproduction in *Trichogramma evanescens minutum R.* with various sugars and polyhydric alcohols.

E. S. NARAYANAN, B. R. SUBBA RAO *and* M. RAMACHANDRA RAO,

New Delhi.

The area under sugarcane in India is about 3 million acres and one of the factors that affect the yield is the damage caused by the sugarcane stem borers like *Chilotraea infuscatellus* Snell. As often times sugarcane is grown in continuous belt in factory farms the rate of multiplication of the pest is enormous, resulting in heavy losses to the factory farms and to the cultivators who grow sugarcane under the auspeces of the management of the sugarcane factories. One of the methods of control adapted to reduce the damage caused by the sugarcane borers is the liberation and colonization of the egg parasite *Trichogramma evanescens minutum* R. This has been done not only in India but in other parts of the world as well, where borers similar to those we have in India, cause the same damage. There has been known two schools holding two divergent opinions as to the effectiveness of this parasite. In Barbados, Tucker has held that sugarcane industry would have been an impossible proposition in the island but for *Trichogramma.* In Lousiana some entomologists like Hines and Herbert Spencer have maintained that *Trichogramma* does good while others do not hold some opinion. But in all these cases fundamental research work on the parasite has not preceeded the liberation and colonization of the parasite in the field. Yet it is one of the prerequisites for any experiment in biological control. *Trichogramma* is one of those parasites that are mass bred in the laboratory and liberated in the field. In this case, there is an enormous scope for the inbreeding of the parasite. This aspect of the problem was therefore studied in the parasite laboratory in some detail. It was observed that the parasites that have been bred for a number of generations under laboratory conditions are inactive, malformed and do not lay the normal number of eggs. So it was thought expedient to introduce new blood. So a consignment of *Trichogramma* parasites were obtained from Mandya (Mysore) and these were crossed with the *Trichogramma* parasites in Delhi. This was done in two ways; the male of Mandya culture was mated with the female of Delhi and the male of Delhi was mated with the female of Mandya. In both the cases the longevity and fecundity of the progeny was studied in detail with feeding with various sugars like—sucrose, glucose, maltose, laevulose and polyhydric alcohols like mannitol and sorbitol. There was a phenomenal increase in the fecundity of the parasite feeding on the sugars and sorbitol. Among the foods, no differences existed as regards their influence on fecundity. A comparison of the parent cultures and the two reciprocal crosses regarding the longevity and fecundity gave very interesting results.

There was a phenomenal increase in the fecundity of the parasite feeding on the sugars and sorbitol. Among the foods no differences existed as regards their influence on fecundity.

A comparison of the parent cultures and the two reciprocal crosses regarding their longevity and fecundity gave very interesting results.

The longevity of the reciprocal crosses is definitely higher than that of the I.A.R.I. parent but not over the Mandya parent. The fecundity was observed to be high in the case of the cross between I.A.R.I. female parent and Mandya male, and also in the case of Mandya parent culture in relation to the other two. The differences between the two newly evolved crosses tend to show differential contribution of each of the parents when used as a male or as female as the case may be.

The differences between the parent cultures and the crosses regarding both the characters under study have given an idea of the possibilities and methods of utilisation of hybrid populations if we may call them so. The existence of differences between parent cultures especially the fecundity of the parasite points to the conclusion that a search for superior stocks of this parasite from different parts of the country has to be made and their longevity and fecundity studied in detail in the laboratory.

## 8. Effect of temperature and humidity on the rate of development of the immature stages and the longevity and fecundity of *Apanteles angaleti* Muesebeck.

E. S. NARAYANAN, B. R. SUBBA RAO *and* T. S. THONTADARYA,
New Delhi.

*Apanteles angaleti* Muesebeck is a vipionid parasite of potential importance in the control of pink bollworm of cotton, *Pectinophora* (*Platyedra*) *gossypiella* (Saunders) which is a cosmopolitan pest and is found throughout the world wherever cotton is grown. *Apanteles* has always been observed to be a shy parasite and it does not generally lay eggs or breed readily in the laboratory. The technique of breeding of *Apanteles* on a mass scale has been developed for the first time in the Parasite Laboratories of the Indian Agricultural Research Institute and a large number of these parasites was sent to the United States Department of Agriculture, Foreign Parasite receiving Station at Moorestown, for mass breeding liberations and establishment in the cotton growing areas of the south and south western States. The ecology and the rate of development of *Apanteles angaleti* under temperatures 12, 15, 20, 25, 30 35 and 40°C and relative humidities of 65% and 85% were studied in detail and it was found that the lower temperatures of 12 and 15°C and higher temperatures of 35 and 40°C in both the humidities were fatal to the development of the host as well as its parasite. The parasite successfully developed and completed its life-cycle only under 20, 25 and 30°C under both the humidity conditions. However, a high temperature of 30°C coupled with 85% relative humidity was detrimental to the parasite's development. The development under field conditions is not constant and the rate of development is governed by the variable temperature and humidity. The parasites complete their development under field condition only during the months of October to April. The parasites generally live longer at lower temperatures of 20 and 25°C under both the humidities. But at 30°C the longevity is better with 65% relative humidity than at 85%. The parasites were fed with various foods like raisin, glucose, sucrose, maltose and fructose. It was found that raisin was the best food under all conditions of temperature and humidity. The female parasites lay the maximum number of eggs under optimum temperature of 27°C and 85% relative humidity. However, light was observed to be an important factor that governed the oviposition habit of the parasite.

## 9. The effects of continuous manuring and cropping on the crop yields, nitrifying power of the soil and nitrogen utilisation by plants.

P. SINHA, Patna.

Numerous workers have found a fairly accurate correlation between nitrifying power of the soil, its nitrogen availability and crop producing power. Very scanty information at present exists in India on the cumulative effects of organic manures, fertilizers and cropping pattern on soil fertility and nitrifying power of the soil It was, therefore, considered appropriate to investigate the long term effects of organic manures such as Farm-Yard-Manure, Oil Cake (Rape cake), fertilizer elements such as N, P, K, and their combinations, green manure, green manure with phosphate and cereal and leguminous crops on soil fertility, nitrogen utilisation by the crop and the nitrifying power of the soil.

In course of these investigations yield data of permanent manurial plots, Pusa (Bihar) were collected; amounts of nitrogen taken up by the crop determined and amounts of nitrate-nitrogen formed on addition of 90 mgms. of nitrogen as ammonium sulphate per 100 gms. of soil were also estimated at the intervals of 1, 2, 3 and 4 weeks at optimum moisture and temperature.

It was found that a fair degree of correlation exists between the nitrifying power of the soil, nitrogen utilisation by the crop and soil fertility. Phosphate brings an all round improvement in soil fertility, nitrifying power of the soil and nitrogen utilisation by the plant when used with nitrogenous fertilizer and green manure. Phosphate is thus the key factor in maintaing soil fertility at a high pitch. Continuous use of Potash on the other hand has definite adverse effects on the nitrifying power of the soil and its fertility. Soil without manuring loses its nitrifying power very considerably. If both nitrogenous and phosphatic fertilizers are combined, their continuous use does not lead to any deterioration in soil fertility regarding the crop yield. Legumes build up both soil fertility and nitrifying power of the soil and their effects are very much enhanced with the use of phosphatic fertilizers. It is, therefore, suggested that adequate amounts of phosphate must be used along with nitrogenous fertilizer or green manure if the soil fertility is to be maintained at a high level.

## 10. Effect of soil amendment on Fusarium wilt of guava (*Psidium guajava* L.) in. Uttar Pradesh.

S. S. JAIN, Kanpur.

In Uttar Pradesh, severe incidence of guava wilt has been observed in alkaline soils. Several foreign workers have reported that hydrogen-ion concentration of the soil influences the growth and parasitism of certain fungi and that some of the soil-borne diseases of plants could be wholly or partially controlled by altering the soil reaction through application of chemicals. A tabulated list of the diseases that are favoured by acid and alkaline soils was prepared by S. D. Garret in 1944.

In 1953, one guava orchard at Lucknow and another at Allahabad, where trees were dying from year to year at a fairly rapid rate, were selected for controlling guava wilt by soil amendment. The soil of both the orchards was alkaline, pH being 7·7 at Lucknow and 7·9 at Allahabad. Ninety six guava trees, 10-12 year old at Lucknow and 112 guava trees of the same age at Allahabad were selected. Lime, molasses and sulphur were applied at the rate of 4 lb. per tree after exposing the roots to a depth of six inches. Check plants were left without treatment. The treatments were replicated 6 times at Lucknow and 7 times at Allahabad. The pH values of representative soil samples from each treatment were determined both before and during the experiments at both the places. The symptoms of the treated and untreated trees were recorded every two months. It was found that the pH value increased in the soil treated with lime while it sharply went down in the case of soil treated with sulphur. Molasses about nine months after treatment brought about only a slight decrease in the pH value of the soil. Increase in the pH value with the addition of lime was maintained up to July, 1954 when it began to diminish.

Significant differences in the average mortalities of the trees in limed and check plots were observed, the average percentage mortality at Lucknow and Allahabad in limed trees being 0 and 10·71 respectively as against 4·16 and 17·85 in controls at the two places. On the other hand, average mortality of trees treated with sulphur and molasses both at Lucknow and Allahabad was significantly higher than in the controls.

## 11. Relation of mosaic disease of Cardamom to Banana Aphis (*Pentalonia nigronervosa* Coq.).

### P. M. Varma.

The banana aphis (*Pentalonia nigronervosa* Coq.) is the specific vector of the mosaic disease of cardamom (*Elettaria cardamomum* Maton).

Single, alate as well as wingless viviparous females, are able to transmit virus but more infection results when larger number of aphids are used to inoculate a plant.

Aphids picked up virus from diseased cardamom plants in a feeding time of 15 minutes, and viruliferous aphids infected healthy plants in a feeding time of five minutes. However, the minimum time for aphids to pick up virus from a diseased plant and successfully transmit it to healthy plant was about 1 hour.

The minimum incubation period of the virus in the aphid is about 30 minutes, but the ability of the aphids to transmit the virus increased appreciably after 1 hour.

The banana aphid was unable to retain the virus and an infective aphid exhausted its virus almost immediately after feeding either on a healthy cardamom or banana plant.

There is no congenital transmission of the virus, but nymphs could acquire the virus from diseased cardamom plants and transmit it to healthy seedlings.

The cardamom plants remain susceptible to infection at all stages of growth. The comparative freedom from disease under natural conditions in case of very young seedlings is due to the fact that the alate aphids do not colonise on these.

## Section XI, Physiology.

### 1. Studies on certain Physiological Norms in South Indian young adults.

C. SITARAMAYYA, N. SYAMALA *and* M. VENKATASWAMY, Guntur.

With a view to find out the physiological norms for young adult South Indians, data of heart rate, respiratory rate, vital capacity, pulse pressure and chest expansion were collected from healthy students of the Women's college and Medical College at Guntur. Total number of individuals so far screened are 334.

Analysis of results so far shows correlation between heart rate and pulse pressure. Their optical levels are reached between 18 to 20 years in girls and 20-22 years in boys. No correlation could be shown between respiratory rate and vital capacity or chest expansion. Age could not be correlated with any respiratory index.

Correlation of cardiac indices is in line with earlier maturation of the female. These results are graphically shown. Further work is being continued.

Appendix- Tabular form.

### 2. "Progressive development of Motor Innervation of the Respiratory Muscles of Human foetus."

DR. C. SITARAMAYYA *and* DR. P. SIMHADRI, Guntur.

Intercostals and diaphragms of human foetuses, from six weeks to full term were histologically investigated by silver and gold impregnation methods, to determine the onset and development of motor and sensory innervation, as well as the growth of the muscle fibres themselves.

The intercostal muscles exhibit cross-striations earlier than diaphragm in all cases—about the 16 weeks age.

Motor innervation is manifest in both cases by about 22 weeks. In fact sensory innervation also can be seen at this stage—contrary to statements in books based upon animal respiratory muscles (other than those of human).

By about 24 to 27 weeks, well defined motor nerve endings are seen; but the adult type of mature motor nerve endings is seen by about 32 weeks. Endoplates show all details of structure by this time. At this time non-respiratory muscles do not show typical innervation.

This early innervation of respiratory muscles is significant; for they function in a much more coordinated manner than the other muscles at birth.

We hope to explore this problem further by electrophysiological techniques etc.

### 3. Relation of Thyroid Gland to Gastric Secretion.

R. C. SHUKLA *and* E. S. NASSET, Lucknow.

*Relation to previous work in this field.*

Watman and Nasset (Amer. J. Physiol. 157, 216-220, 1949) demonstrated that removal of the thyroid gland reduced significantly the time required for perforation of a histamine-induced peptic ulcer in the guinea pig. The thyroidectomized animals reaction was restored to normal by administration of whole desiccated thyroid gland but not by administration of crystalline thyroxine. These results suggested an important control of gastric function by some non-thyroxine thyroid factor.

In order to make direct observation on gastric secretion, Nasset and myself began experiments on dogs bearing gastric pouches. This work was still in progress when he left this country for his own.

Preliminary results show that feeding of soluble portion of thyroid gland to the dog will diminish his gastric secretion by approximately 50%. Thyroxine (crystalline) appears to have no effect. These results confirm those obtained in the guinea pig with slight modification.

## 4. Saltless Diet (Common Salt).

S. N. MATHUR, Bhopal.

By some accident I was led to do the experiments on the saltless diet on myself. For some twenty years I was having now and then missing of heart beats. They were not present at all times but only appeared now and then, some times for weeks together and then would disappear for years. When they appeared, they had no regular sequence. For some minutes they were more frequent and some times appeared after hours. In short they were very irregular. As they did not give any trouble of any sort excepting the awareness and a sort of funny sensation, I did not care either to cure them by any medicine or even to come to a correct diagnosis as to their origin, cause etc. Over a year ago I had to keep a fast. I may mention that the fast was probably taken after over forty years. To my surprise the extrasystoles which were present at that period disappeared as if by magic. This led me to do experiments on fasting. Whenever I fasted they always disappeared. For a certain reason, after sometime on one day I took saltless diet. The extrasystoles which happened to be present at that time, again disappeared. This led me to do further experments on saltless diet alone. For over six months I did these experiments and found that with mathematical regularity the extrasystoles, whenever they were present, disappeared on saltless diet. At the same time whenever the saltless diet was taken there was a general sense of well being; the sense of fatigue and breathlessness on exertion became much less; the capacity to do muscular work increased very much. About five months back I had an occasion of again taking a saltful diet in all the three principal meals. This was after a month of saltless diet. The extrasystoles did appear and appeared in some intensity. Naturally I left the salt. This time their disappearance was not so miraculous as on previous occasions. It was on the third day of saltless diet that they did disappear. I have not taken salt since then. And have not known them as well.

It may however be mentioned I am on natural foods and I believe they contain more than the minimum requirements of sodium chloride. The extra salt which men add to their diets seems not to be only unnecessary but harmful in the amounts which are usually taken.

## 5. Vitamin "A" and Elastic Tissue.

OUDESH NARAIN *and* S. N. MATHUR, Bhopal.

The senior author has been observing on himself for a large number of years that the pains in the back come and go with the deficiency and supply of vitamin A. The pains in the back were thought to be due to over-working of small muscles of back which was again thought to be due to their taking up the work of the elastic ligament which on account of their elasticity kept the vertebral column in its correct position and which they could not keep due to some loss of elasticity and thus the small muscles of back took that work upon themselves. In other words the pain in the back was probably due to fatigue of these muscles. When vitamin A relieved these pains it was conjectured that might be due to its bringing back the normal elasticity of these ligaments. The present observations are a record of animal experiments. The animals chosen were guinea-pigs, rabbits, rats and pegeons. In all it has been found that the elasticity of the elastic tissue—ligaments of joints, of neck, and the arteries increases and decreases with the giving and taking away of vitamin A from their natural diet.

These observations find confirmation on the statistical observations on diet of tubercular patients. To my mind it appears that the deficiency of vitamin A in their diets decreases the elastic recoil of their lungs which therefore can be a cause of deficient aeration of their blood and consequent vicious cycle.

## 6. Temperature Regulation and Salt. (Common Salt).

S. N. Mathur, Bhopal.

It is well known that sodium lies mainly outside the cells in the intercellular spaces. The intercellular spaces are thus storehouses for sodium chloride and consequently of water. In hot countries people usually take more salt to store water for heat regulation. I have observed that in a saltless diet the perspiration is definitely less. On the other hand in a saltful diet it is always definitely more, much more than what gets evaporated from the skin for temperature regulation. It appears that skin specifically excretes Sodium chloride, and as it must be excreted alongwith water, it seems as though the sodium chloride is looking for the opportunity to be excreted out which it gets when water is excreted out in larger amounts for the need of temperature regulation. Therefore sweating is not just for temperature regulation but is also needed for salt excretion. If the salt is not required to be excreted the extra perspiration is cut off without any loss of the efficiency of the temperature regulation.

It may however be mentioned that workers in mines, under conditions of high temperature and humidity (and I suppose that they alone) may need an extra supply of salts. Even in them their efficiency of work should very much increase if instead of giving this extra salt their working conditions are improved in such a manner that temperature is regulated by the evaporation of water and sweat is secreted only for that purpose; and not for excreting the unnecessary extra salt. For excreting this extra salt an equivalent amount of extra blood is being unnecessarily diverted to the skin at this expense of muscles. The extra salt may thus be cut down. This will not only add to their efficiency of the circulatory and respiratory systems but will spare extra blood to their muscles.

## 7. Age and Blood pressure.

S N. Mathur, Bhopal.

Over fifteen years ago in some session of this Congress I read a paper on blood pressure which was a statistical observation of several thousand blood-pressure readings on several hundred young men. It was then found that the range of blood pressure was from 100 to 200 systolic and that the blood pressure could rise and fall to that extent in any young man in a twinkling of an eye. There I had also told that the blood pressure did not necessarily rise with the age and that if it did rise it was not due to age but to some other causes. Now

I am bold to say that the cause of rise of blood pressure with age is probably due to dullness of sensations with the age and making good this dullness with extra salt and spices. It may now be mentioned that my blood pressure—and I am over sixty years old—now ranges from 108/62 to 125/78 though on one or two occasions it has gone as high as 150/84 and as low as 102/68. I am taking these readings several times during the day under different conditions. I am not taking salt these days and have no idea of my blood pressure before I left the salt, but I suppose it must have been higher. This view had found confirmation in my observation on others, of my age as well as in much youngers. I have observed that the blood pressure is directly proportional to the amount of salt in the diet. It is not just a question of rise and fall of blood pressure but there is an all round improvement in the actions of the cardio-respiratory system as if a load has been taken away from it.

## 8. Further Work on "Double Role of Respiration".

J. S. SAKSENA, Bhopal.

In the 41st session of the Indian Science Congress, Dr. Mathur read a paper in which he showed that Respiratory mechanism serves two purposes—the depth regulating the oxygenation; and the rate, the temperature.

Further quantitative work has been done to confirm the above contention, namely arterial blood analysis in dogs and study of one minute expired air samples in human volunteers.

1. Study of oxygen saturation of arterial blood in dogs—changes in rate and depth were produced by (a) Heating, (b) Breathing of $CO_2$ and $O_2$ mixtures, (c) Intravenous injection of chemical substances and (d) Artificial respiration.

It was observed that the oxygen saturation of blood varied, according to the depth of respiration and was independent of the rate. The cause of the change in depth of respiration was immaterial.

2. Study of Expired Air Samples in Human Volunteers—The volume, oxygen percentage and $CO_2$ percentage of 4 one-minute samples of expired air collected at normal and voluntarily reduced rates were determined in 35 volunteers. The depth of respiration was not voluntarily regulated but allowed to change with the change in rate. Knowing the composition of inspired air, the oxygen absorbed and $CO_2$ given out in one minute was calculated in each case.

The oxygen uptake per minute was found to increase progressively in all cases when the rate of respiration was reduced from the normal to 8 per minute, while in most cases it continued to rise even when the rate was reduced to 4 per minute. This is evidently due to the increase in depth exposing more hidden alveolar spaces which do not operate in shallow breathing.

Alveolar air samples were also analysed in dogs and human beings.

It was also observed that the rectal temperature of dogs breathing at a slow rate for prolonged periods showed a small but steady rise. It fell during the hyperpnoea following ether anaesthesia.

Thus the "Double Role of Respiration" is further confirmed viz. Depth regulates gaseous exchange while rate is meant mainly for temperature regulation, and, in all probability, exclusively for temperature regulation in dogs.

## 9. Some Observations on Saltless diet.

J. S. SAKSENA, Bhopal.

These observations have been made on a saltless diet that is one in which no extra sodium chloride was added to natural foods. It was observed that urine output and thirst were both markedly diminished within four days of starting the

"Salt free regime" thus showing that the large amounts of water drunk and execreted by the kidneys was in no way beneficial for the body economy. It served only to get rid of the extra amounts of sodium chloride taken, which needs must have water for its elumination. This extra sodium chloride was not only useless but positively harmful to the body.

It appears that sodium chloride is excreted not only through the kidney but also through the skin, the latter being far more than what would be automatically excreted out with the amount of sweat necessary for temperature regulation.

It was found, that blood pressure never rises to a high figure on a saltless diet. Also the blood pressure and pulse rate usually go parallel rather than in opposite directions. The rise in pulse rate on exertion is less and of shorter duration on a saltless than in a saltful diet.

On a few occasions, urine was analysed and chlorides in terms of sodium chloride were found to be between 0·2% to 0·3%. The chloride excretion now represented chlorides other than sodium which was practically absent from urine. It is well known that the extra sodium chloride which one takes in the diet is all excreted out within 24 hours. This is clear from the fact that 99% of the sodium chloride is reabsorbed and only 1% is reabsorbed in the kidney . This 1% can be amply supplied by the sodium chloride present in natural foods.

The above observations find confirmation in the fact that when I used to take salt diet, and a little more than others, I used to sweat far more profusely than at present, although there is no loss of efficiency of temperature regulation even now. In fact the efficiency is far more now, as is evident from the fact that far more muscular work can be undertaken without fatigue and breathlessness. That the sodium chloride does get excreted from the skin, even though there may be no necessity of temperature regulation is shown by the observation that the skin, if licked, has always a saline taste, irrespective of the season and muscular activity. On leaving salt, the saltish taste of the skin has disappeared.

## 10. Further Observations on the Mechanism of Temperature Regulation in dogs.

SURENDRA KUMAR, Patna.

In connection with the papers that I read previously in this Science Congress regarding the temperature regulation in dogs the experiments done subsequently show that there is a well regulated balance of water in the dog's body. It was now observed that in those dogs in which the respiratory accelerator reflex on opening of the mouth did not appear up to 42°C the mouths were much less wet than observed in the dogs in which the reflex appeared. The reflex however, appeared after injection of saline. It appears therefore, that temperature regulation is of secondary importance to the conservation of water in the body.

## 11. Effect of Some Antimalarial Drugs on the Biosynthesis of Acetylcholine in Rat Tissues.

B. C. BOSE *and* S. S. GUPTA, Indore.

Effect of some anti-malarials—paludrine, mepacrine and quinine on the acetylcholine synthesis in the tissues of rats fed on synthetic diet containing a small percentage of the above drugs was studied. Acetone dried extracts of heart, brain and liver of these rats were assayed against acetylcholine chloride by using a strip of frog rectus suspended in 'Leech apparatus containing Ringer' solution.

The average acetylcholine per gram of tissue was compared in different groups with that in the tissues of the control rats. The results indicate that all the three anti-malarials caused a significant reduction in the acetylcholine content in all the tissues studied. Reduction was most marked with paludrine while quinine and mepacrine caused a moderate reduction. These drugs seem to inhibit directly or indirectly certain co-enzymes necessary for dehydrogenase systems responsible for the synthesis of acetylcholine. Marked inhibition of this synthesis by paludrine may be explained by its antagonising effect on folic acid and glutamic acid which have been shown to affect the acetylcholine synthesis to an appreciable extent.

## 12. A Method of Collecting Alveolar Air from Animals.

J. S. SAKSENA, Bhopal.

For the first time, a method of collecting alveolar air from animals is described. In place of the voluntary prolonged expiration used in collecting alveolar air from human beings, "forced Artificial Expiration" is used, the last portion of which consists of alveolar air. The method can be used for acute experiments as also for repeated determinations on the same animal.

## Section XII. Psychology and Educational Sciences.

## 1. Retro-active Inhibition : A reaction to Ego-threat.

S. M. MOHSIN, Patna.

A hypothesis was made that the loss of memory noted in experiments on R I may be due to repression as a reaction to Ego-threat. The learning task and/or the interpolated activity used in the experiments may be taken by the subject as a test of ability and thus offer a threat to self-esteem. S may react to the threat by a feeling of failure and self-inadequacy. The emotional disturbance thus caused, may affect the memory for the associated materials. The retention test may show on this account, and not retro-action, a loss of the memory.

Thirty under-graduate students were used as subjects. They were divided into three groups : one control and two experimental. The usual procedure for experiments on R I was adopted. The learning material consisted of a list of digits. The learning was partial—6 trials. Recall and relearning tests of retention followed after 20 minutes. During this interval, the control group relaxed. The Experimental Groups did code-writing, one group doing it under task-orientation, while the other group taking it as a test of ability under condition of anxiety experimentally induced : ego-orientation.

There was no evidence of inhibition due to retroaction.

Some evidence of inhibition was noted that could be attributed to repression as it affected only the ego-oriented group.

The ego-oriented group performed significantly much better in the code-writing than the task-oriented group, which shows the motivating influence of ego-threat.

More experiments are needed before a thorough examination of the hypothesis is possible.

## 2. A Note on the Calculation of 'Co-efficient of Belonging'.

D. N. LAL *and* J. K. PRASAD, Patna.

A method for the calculation of 'Co-efficient of belonging' is outlined and it is expected that with the table provided it will simplify a lot of heavy calculation needed to assign factors to a particular group.

## 3. A Simple Device to Establish Sequence in Multiple Choice Item Options.

M. A. HAKIM, Agra.

The test-constructor's biases in the ordering of multiple choice item options are detrimental to the interest of a true test. McNamara, Weitzman, Chronbach, and others have shown that choice placement has an effect on item difficulty when biased instruments are used. To overcome this difficulty, and to assist the test constructor in randomizing the order of five option multiple choice item responses a *card-sorting* device, which the author thinks has definite advantages over other techniques, is advocated.

## 4. A Study of Intelligence Scores with and without Time-Limit.

MOHAN CHANDAR JOSHI, Banaras.

In the course of preparing a standardized group test of general mental ability I selected seven elements containing 175 items. These elements were administered individually on 7 groups of students of 200 each without any time-limit. From the *item-analysis* of these scores a "Spiral omnibus" type of test (28/55) was prepared containing 100 items. This test was administered upon a group of 863 students (VIIIth to XIIth classes) with a time-limit of 20 minutes. The item-analysis of these scores made it necessary to revise this test and accordingly test 30/55 was prepared and administered on two groups of students (IXth and Xth classes) with the usual time-limit of 20 minutes. But to find out the 'time-bias' of this revised test we administered it on another group of 25 students of Xth class both with and without the time-limit. This has yielded the following results :

(1) Scores with and without time-limit correlate very highly (Product Mom. $r = \cdot 926 \pm \cdot 0038$). This may imply that 'speed' make no significant change in the scores.

(2) The 'superior', 'average', and 'dull' groups have an average gain of 8·6, 15·2, and 23·4 scores respectively in the time-less condition.

(3) The above mentioned three groups have taken on the average 24′-3″, 35′-36″, and 46′-39″ respectively in completing the test.

(4) It appears that 'time' has a moderate effect on the 'average' group.

(5) There is a considerable change in the difficulty-value of the test elements under the two conditions. This is specially significant in the case of the Number series and the Reasoning items.

## 5. A Projective Technique Involving the Textile-Kinaesthetic Modalities.

SHEREEN K. MADAR, Bombay.

The projective test described here is a development of the technique carried out between 1950-1955 and reported at a meeting of the British Psychological Society.

Three-dimensional objects were constructed as 'unstructed' as possible in a variety of materials. They varied in size, shape, weight, texture and compressibility. Materials such as clay, wood, wax, plastic, rubber and 'bouncing putty' were used in their construction.

Ten such objects were presented to the subject in a standardized way. The object was placed singly under a screen, which prevented the subject from seeing it, but enabled him to manipulate it as he chose. Each section of the object was marked to facilitate accurate recording.

There were 20 scoring categories. The 'Location' nad 'Content' categories were similar to the Rorschach.

The results of 44 normals were compared with 44 neurotics and 44 psychotics matched for age, sex, intelligence and verbal fluency.

Nine variables were found to differentiate between the normal and clinical groups. This study opens up avenues for further research.

## 6. Rorschach Responses of a group of juvenile thieves.

UDAY SHANKER, Delhi.

The Rorschach test was given to 40 juvenile thieves of ages between 14 and 17 individually in the district jail, Delhi, after studying their case histories and background. The purpose of the study was to see if the Rorschach categories, when interpreted individually gave any indication of delinquent character formation.

Certain interesting results have emerged which throw light on the validity of the Rorschach test in so far as the variables bring out the juvenile delinquent personality characteristics. Broadly speaking the group on the whole gave an abnormally high d and D than W and a number of components of S responses. There was a high A and Ad% and a low H% which together with predominence of FM over M brought out the juvenile mind living on a level of instinctive prompting. There were signs of marked anxiety and insecurity and inadequate personality development given by the shading and m responses. Aggression, hidden fear and suffering were shown in the morbid contents. High F% going with almost equal F—indicated if not low intelligence but the impairment of upsetting of critical faculties of reason. M : c ratio indicated some extratensive trends. The findings of the study agree partly with those of Beck and in some respects with those of Zulliger. The entire field of juvenile delinquency, however, still requires much investigation.

## 7. A Study of the H. H. Responses of Adult Abnormals.

N. L. DOSAJH, Jullundur.

The present study deals with the responses of the adult abnormals. The H. H. test was administered to various types of adult abnormals. The responses obtained were scrutinised. A summary of the observations is as follows :—

1. There is more of Ego-projection in abnormals than in the normal subjects.
2. The number of the 'Whole' responses is less in the case of the abnormals than in the case of the normals.
3. There is a preponderance of simple, discrete, uncoordinated sketches, having no relation either verbal or spatial, in the case of abnormals.

4. Some abnormals drew mostly lifeless sketches.
5. The dangerously aggressive types of prisoners e.g. dacoits and murderers, in the District Jail, Jullundur showed a good many drawings of sharp-edged weapons e.g. swords, knives, spears, guns and pistols.
6. One abnormal drew mostly the sexual parts.
7. A few abnormals drew morbid and horror images which were quite unreal.
8. The drawings of the abnormals were marked by lack of precision and uniformity.
9. The manner of approach of the abnormals was mostly impulsive and showed diffidence.
10. The abnormals were generally distracted and restless during the test and gave up the task very often.
11. While taking the test, the abnormals showed a good deal of emotional excitement and made unnecessary and meaningless gestures.

## 8. Planning Psychological Research in India.

A. K. P. SINHA, Patna.

A great demand for the development of Psychology as a profession as well as a science and a technology is keenly felt in India. But though the demand is already great, our contribution so far has been far from satisfactory. Research work in this direction is, therefore, an urgent need now. And programmed research can advance Psychology far more rapidly than Psychology has advanced hitherto through the uncoordinated efforts of individuals.

There is no antithesis between basic and applied research, for basic research is often stimulated by applied research done mainly because of practical needs, and a sound basic research policy is the foundation for later developments on the applied side.

Although a good deal of work in different areas of Psychology has to be done in our country with a rather rapid pace, we may confine ourselves for the present to some of the important ones only. For instance, we need very much bringing out in the next five years different sorts of tests suitable for different purposes and to bring them out in the most helpful way. The problem of mental health again is completely neglected in our country. And the magnitude of the mental health problem is not to be measured by merely counting the number of people now in mental hospitals, for we don't have very many much hospitals in our country. Besides those who are institutionalised, there are many others considered relatively normal who nonetheless have severe and crippling emotional problems. Similarly, we need doing intensive research in such areas as guidance, selection, training human engineering, group morals, efficiency, social prejudice etc.

## 9. Proposed Scheme for the Higher Secondary Public Examination in India.

S. S. MATHUR, Agra.

The present system of public examination suffers from many major defects. To overcome them completely a new scheme of public examination at the higher secondary stage is presented here.

It is proposed that there should be only one public examination at the end of the secondary stage. A candidate appearing in this examination should be examined in five subjects only. In each subject a candidate be required to appear in two written-papers. (One containing essay-type questions and the other questions of objective-type.) The setting of these papers would be centrally administered. There should also be an oral test. Due credit for a candidate's class-work should be given in his final assessment.

One external examiner in each subject in each institution be appointed. The examiners would proceed to the institutions allotted to them to examine the candidates in viva-voce and also to examine the answer-books of both the written-papers.

For a candidate the five external examiners and the principal of the institution would constitute the board of examiners. The board would meet after the oral examinations are over to tabulate and discuss the results.

In practice this scheme would not put any extra-financial burden on the Government or the candidates.

# DISCUSSION

## I. Geometry Complex Manifold

## SECTION OF MATHEMATICS

*Chrirman :* DR. RAM BEHARI

### 1. RAM BEHARI (Delhi) : *Differential Geometry of Complex manifolds*

Consider a real 2n dimensional manifold $V_{2n}$ of class $C^r$ with a given covering by neighbourhoods each endowed with a coordinate system

$$z^{\alpha} = x^{\alpha} + ix^{\alpha} \qquad \text{where } \alpha = 1, \ldots, n;\ \bar{\alpha} = 1, \ldots, n$$
$$z^{\alpha} = x^{\alpha} - ix^{\alpha}$$

Then we have a one to one correspondence

$$(z^{\alpha}, \bar{z}^{\alpha}) \rightleftarrows (x^{i}). \quad i = 1, \ldots, n, \quad 1, \ldots, \bar{n};$$

and $(z^{\alpha}, \bar{z}^{\alpha})$ may be considered to be coordinates of a point in the real $2n$-dimensional manifold $V_{2n}$. In what follows the Latin indices will take the values $1, 2, \ldots n, \bar{1}, \bar{2}, \ldots, \bar{n}$ the unbarred Greek indices will take the values $1, 2, \ldots, n$ and the barred Greek indices will take the values $\bar{1}, \bar{2}, \ldots \bar{n}$.

Now, if we can cover the manifold entirely by system of coordinate neighbourhoods each endowed with complex coordinates $(z^{\alpha}, \bar{z}^{\alpha})$ and if, $U_1$ and $U_2$ being two complex coordinate neighbourhoods of the manifold, a point $P$ belongs to $U_1 \cap U_2$ then the complex coordinates $z'^{\alpha}$ of the point $P$ in one of these complex coordinate neighbourhoods are complex analytic functions with nonvanishing Jacobian of the complex co-ordinates $z^{\alpha}$ of the same point, *i.e.*

$$z'^{\alpha} = \psi^{\alpha}(z), \qquad \bar{z}'^{\alpha} = \bar{\psi}^{\alpha}(\bar{z}). \tag{1.1}$$

where $\bar{\psi}^{\alpha}(\bar{z})$ denotes the complex conjugate of the function $\psi^{\alpha}(z)$. Also if we put $\bar{z}^{\alpha} = z^{\bar{\alpha}}$ and assume that barred Greek indices take the value $\bar{1}, \bar{2}, \ldots, \bar{n}$, then for $(z^{\alpha}, \bar{z}^{\alpha})$ we can write $z^{i}$, $(i = 1, 2, \ldots, n, \bar{1}, \bar{2}, \ldots, \bar{n})$ and for the transformation (1.1) we can write

$$z'^{i} = f^{i}(z)$$

The Jacobian of (1.1) is easily seen to be $\left| \dfrac{\partial z'^{i}}{\partial z^{j}} \right|$ which is real and greater than zero. Thus the manifold is always orientable.

We shall denote a complex analytic manifold of complex dimensions $n$ by $C_n$. In $C_n$ vectors, tensors, affine connections etc. are defined with respect to coordinate transformation (1.1) in the same way as in the case of real manifolds.

We define any quantity to be self adjoint if barring and unbarring all indices simultaneously of a component changes a component into its complex conjugate.

Now assume that in our complex analytic manifold, there is given a positive definite quadratic form

$$ds^2 = g_{jk}\, dz^j\, dz^k,$$

where the symmetric tensor $g_{jk}$ is self adjoint,

$$g_{\alpha\beta} = g_{\bar\alpha\bar\beta} = 0$$

so that the metric form can be written as

$$ds^2 = 2g_{\alpha\bar\beta}\, dz^\alpha\, d\bar z^\beta,$$

where

$$g_{\alpha\bar\beta} = g_{\bar\beta\alpha} = \overline{g_{\bar\alpha\beta}} = g_{\beta\bar\alpha}$$

This metric is called a Hermitian metric. Taking account of

$$g^{\alpha\beta} = g^{\bar\alpha\bar\beta} = 0, \qquad g^{\alpha\bar\beta} = g^{\bar\beta\alpha} = \overline{g^{\bar\alpha\beta}} = g^{\beta\bar\alpha} \tag{1.2}$$

we obtain the Christoffel symbols

$$\left\{{\alpha \atop \bar\beta\gamma}\right\} = \tfrac{1}{2} g^{\alpha\bar\varepsilon}\left(\frac{\partial g_{\bar\varepsilon\beta}}{\partial \bar z^\gamma} + \frac{\partial g_{\bar\varepsilon\gamma}}{\partial z^\beta}\right),$$

$$\left\{{\alpha \atop \beta\gamma}\right\} = \tfrac{1}{2} g^{\alpha\bar\varepsilon}\left(\frac{\partial g_{\beta\bar\varepsilon}}{\partial z^\gamma} - \frac{\partial g_{\beta\gamma}}{\partial \bar z^\varepsilon}\right), \qquad \left\{{\alpha \atop \bar\beta\bar\gamma}\right\} = 0.$$

and the values of other components are given by symmetry and self-adjointness. If in addition we assume

$$\frac{\partial g_{\bar\alpha\beta}}{\partial z^\gamma} = \frac{\partial g_{\bar\alpha\gamma}}{\partial z^\beta} \tag{1.3}$$

or further

$$g_{\alpha\bar\beta} = \frac{\partial^2 \phi}{\partial z^\alpha \partial \bar z^\beta}, \tag{1.4}$$

then the condition (1.3) or (1.4) is called Kaehler condition and the metric satisfying (1.2) and (1.4) is called a Kaehler metric and the manifold is called a Kaehler manifold.

In a Kaehler manifold an orthogonal ennuple of vectors can be studied and Ricci's coefficients of rotation can be obtained and their properties discussed. Normal congruences, geodesics and geodesic congruences in a Kaehler manifold also form interesting study. It is also worthwhile studying the complex hypersurfaces and the subspaces of a Kaehlar manifold, as well as the conjugate directions and the various lines e.g. the lines of curvature etc. in the complex hypersurfaces and the subspaces of the manifold.

## 2. R. S. MISHRA (Delhi) : *Differential Geometry of $K_n$—connected spaces.*

In an $n$-dimensional complex space $C_n$ in the sense of S. Bochner we take allowable coordinates

$$Z^1, \ldots, Z^n, \quad \bar{Z}^1, \ldots, \bar{Z}^n,$$

and the allowable transformation group

$$Z'^{\alpha} = \phi^{\alpha}\,(Z^1, \ldots, Z^n)$$

$$\bar{Z}'^{\alpha} = \psi^{\alpha}\,(\bar{Z}^1, \ldots, \bar{Z}^n)$$

where the functions $\Phi^{\alpha}$ are power series obtained from the power series $\psi^{\alpha}$, by replacing each coefficient by its conjugate complex value. All functions which define components of any geometric quantity in $C_n$ are power series with complex coefficients in $2n$ complex variables $Z^{\alpha}$, $\bar{Z}^{\alpha}$. We consider complex analytic geometric quantities and assume self adjointness on the indices.

In this talk, we consider $n$-dimensional unitary $K_n$-connected spaces whose metric is defined by the positive definite Hermitian form, and whose parameters of connections are given by

$$\Gamma^{\alpha}_{\beta\gamma} = a^{\sigma^*\alpha} \frac{\partial a_{\beta\sigma^*}}{\partial z^{\gamma}} \qquad \text{(conjugate)}$$

The necessary and sufficient conditions that this space admits an analytic geodesic curve with real parameter have been found and the result has been applied to the case when the space is Hermite-Kaehler. The Frenet-Serret formulae for this curve have then been studied and a number of results have been obtained when the curve is generalised Hermitean circle or helix.

Subspaces of these $K_n$- connected spaces have then been studied and Gauss and Codazzi equations have been deduced and their generalisations have also been obtained when instead of mutually orthogonal unit normals congruences of curves through points of the subspace have been considered.

The above gives the investigations of Suguri and some of my own investigations.

## 3. (Mrs.) KAMLA DEVI SINGH (Lucknow) : *Subspaces of a Kaehler manifold*

Consider a real $2n$ dimensional manifold $V_{2n}$ with coordinates $x^i$ $(i = 1, \ldots n, 1, \ldots, \bar{n}).\ \bar{1}\ \bar{2}, \ldots, \bar{n})$ and metric $g_{ij}\, dx^i\, dx^j$ immersed in a $2m$-dimensional manifold $V_{2m}$ with coordinates $y^{\alpha}(\alpha = 1, 2, \ldots, m, 1, \bar{2}, \ldots, m)$ and metric $a_{\alpha\beta}\ dy^{\alpha} dy^{\beta}$.

If we put

$$Z'I = xI + ix\bar{I} \qquad (I, J, K, \ldots = 1, 2, \ldots, n)$$

$$\bar{Z}'I = xI - ix\bar{I} \qquad (\bar{I}, \bar{J}, \bar{K}, \ldots, \bar{1}\ \bar{2}, \ldots, \bar{n})$$

$$Z^{\lambda} = y^{\lambda} + iy^{\bar{\lambda}} \qquad (\lambda, \mu, \nu \ldots = 1, 2, \ldots, m)$$

$$\bar{Z}^{\lambda} = y^{\lambda} - iy^{\bar{\lambda}} \qquad (\bar{\lambda}, \bar{\mu}, \bar{\nu} \ldots = \bar{1}, 2, \ldots, \bar{m})$$

then we have a one to one correspondence

$$(Z'I,\ \ Z'I) \rightleftarrows (x^i) \quad \text{and} \quad (Z^{\lambda},\ \ Z^{\bar{\lambda}}) \rightleftarrows (y^{\alpha})$$

We assume $V_{2m}$ to be complex analytic so that

$$Z'^{I} = \psi^{I}\,(Z), \qquad \bar{Z}'^{I} = \bar{\psi}^{I}\,(\bar{Z})$$

where $\bar{\psi}^{I}$ is the complex conjugate of the function $\psi^{I}\,(Z)$, It has been shown in this talk that subspaces of such Kaehler manifold is Kaehlerian. Ricci identities have been found as follows

$$A^{\lambda}{}_{;IJ} - A^{\lambda}{}_{;JI} = 0 \qquad \text{(conjugate)}$$

$$A^{\lambda}{}_{;\bar{I}J} - A^{\lambda}{}_{;J\bar{I}} = 0 \qquad \text{(conjugate)}$$

$$A^{\lambda}{}_{;I\bar{J}} - A^{\lambda}{}_{;\bar{J}I} = A^{\delta}\theta^{\nu}{}_{,\bar{J}}\,\theta^{\mu}{}_{,I}\,\Gamma^{\lambda}{}_{\delta\bar{\mu}\gamma} \qquad \text{(conjugate)}$$

where $\theta^{\nu}{}_{,J} = \frac{\partial Z^{\nu}}{\partial \bar{Z}'^{J}}$ and semi-colon followed by an index denotes tensor derivative.

If $\Omega_{\nu'|IJ}$ are the coefficient of the second fundamental form, then

$$\Omega_{\nu'|I\bar{J}} = 0 \qquad \text{(conjugate)}$$

$$\Omega_{\nu'|IJ} = \theta^{\lambda}{}_{;IJ}\, a_{\lambda\bar{\mu}}\, \bar{N}^{\mu}{}_{\nu'|} \qquad \text{(conjugate)}$$

With the help of these and some other relations a number of results relating to normal curvature vectors, first curvature and unit normals have been established.

In the last section subspaces with indeterminate lines of curvature have been studied and certain results are deduced.

## 4. Gita Halder (Delhi) : *On Kaehler Manifold*

I have introduced a new concept defined as 'Automorphic equivalence' in Kaehler manifolds whereby, in a Kaehlerian $C_n$ (of real dimensions $2n$) two tensors of the same order $(2l+1)$ for any $l$, are automorphically equivalent, if one is the transform of the other under the automorphism $z'^{\alpha} = ez^{\alpha}$, $z'^{\bar{\alpha}} = \bar{e}z^{\bar{\alpha}}$,

where $\alpha = 1, 2, \ldots, n$; $\bar{\alpha} = \bar{1}, \bar{2}, \ldots, \bar{n}$; $e = \pm i$ and $\bar{e}$ is the conjugate of $e$.

Orthogonal ennuples in a Kaehler $C_n$ are obtained with the help of automorphic equivalence. Ricci coefficients are defined in analogy with Riemann spaces and various properties of Ricci coefficients are obtained. Also the equations satisfied by the Ricci coefficients, when one or all the congruences of curves forming the ennuple happen to be normal congruences or geodesic congruences, are obtained.

The Kaehler hypersurface is defined and the normal plane to the hypersurface is obtained with the help of automorphic equivalence. The second fundamental tensor is defined in analogy with Reemann spaces and conjugate directions and lines of curvature are obtained. It is proved that the mean curvature for a Kaehler hypersurface is zero, although the lines of curvature are not ideterminate. The number of orthogonal ennuples in a Riemannian $V_{2n}$ and in a Kaehlerian $C_n$ have been studied.

## 5. S. C. Saxena (Delhi) : *On Kaehler Complex Manifold*

The equations of the geodesics in a Kaehler manifold have been deduced both by ordinary method and by the method of calculus of variations.

Hypersurfaces in a Kaehlar manifold have been defined and the properties of curves in a hypersurface have been studied. The equations of Gauss and Codazzi have been obtained in a Kaehlar manifold.

The condition that a Kaehlar manifold may be conformal to another Kaehler manifold has been decuced and an expression for conformal curvature tensor has been obtained.

Euclidean spaces of a Kaehlar manifold have been studied. Hyperquadrics for an Euclidean space have been defined and the following result for a hypersurface of an Euclidean space has been obtained.

"The holomorphic curvature of a hypersurface of an Euclidean space determined by a self adjoint unit vector is equal to four times the square of modulus of normal curvature of the hypersurface in that direction."

6. M. C. CHAKI (Calcutta) : *Parallel field of complex planes.*

The notion of parallel field of planes of a complex manifold has recently been used to study the nature of the manifold. A necessary and sufficient condition for a 2m-dimensional manifold to admit a complex analytic structure, as given by W. V. D. Hodge, is that there should exist in the manifold a tensor field and an affine connection. This result has been interpreted by E.M. Patterson in terms of complex parallel planes. He has also characterised a Kahler manifold in terms of a particular parallel field of complex planes (*Jour. Lond. Math. Soc.*, 1953)

## II. Linear Operators.

(*Jointly with Physics Section*)

*Chairman :* DR. R. N. SEN.

1. S. M. SHAH (Aligarh) :

I. *Eigenfunction Expansions.* We consider the linear operator

$$L = q(x) - \frac{d^2}{dx^2},$$

where $q(x)$ is a given function of $x$ defined over some interval, operating on a function $y$. If $L$ satisfies the equation $Ly = \lambda y$, then we are led to the equation

$$\frac{d^2y}{dx^2} + \{\lambda - q(x)\}y = 0 \tag{1}$$

A function which satisfies this equation and given boundary conditions is called an eigenfunction. If $q(x) = 0$, we get the expansion formula

$$f(x) = \frac{1}{\pi}\int_0^\infty \frac{\sqrt{\lambda}\psi(x, \lambda)}{\cos^2\alpha + \lambda\sin^2\alpha}\,d\lambda \int_0^\infty \phi(y, \lambda)f(y)dy,$$

where $\phi(x, \lambda)$ is a known function. [E. C. Titchmarsh, Eigenfunction Expansions, 1946, pp. 59-60]. If $q(x) = -x^2$ we get the expansion formula

$$f(x) \quad \frac{1}{\pi^2}\int_{-\infty}^{\infty} \left|\Gamma\left(\frac{3}{4} + \quad\right)\right|^2 e^{\frac{\pi\lambda}{4}}\phi(x, \lambda)d\lambda \int \phi(y, \lambda)f(y)dy,$$

where $\phi(x, \lambda)$ can be calculated in terms of $D_n$ functions. By an application of the residue theorem, we get

$$f(x) = \sum_{0}^{\infty} \frac{e^{-\frac{i\pi}{4}} e^{\frac{ix^2}{4}} H_{2k+1}\left(xe^{\frac{3i\pi}{4}}\right)}{2^{2k}\sqrt{\pi}\,(2k+1)!} \int_{0}^{\infty} e^{\frac{1}{4}iy^2} H_{2k+1}\left(ye^{\frac{3i\pi}{4}}\right) f(y)dy,$$

wher $H$ are Hermite polynomials. We can similarly obtain a formula involving Hermite polynomials of even order. Since any fuction can be expressed as the sum of an even function and an odd function, we can get the expansion for any function $f(z)$ satisfying certain regularity conditions in (i) a series of functions, (ii) a series of Hermite polynomials. (S. M. Shah, J. Lond. Math. Soc., 27 (1952), pp.58-64). If $q(x) \to +\infty$ and satisfies certain condition of regular growth, then it is possible to give fairly precise results about the distribution of the eigenvalues of the differential equation (1).

II. *Operatons connected with entire functions*

Let $F(z) = \sum_{0}^{\infty} a_n z^n$ be an entire function. We consider the differential operator $F(D) = \sum_{0}^{\infty} a_n D^n$. It is known that this operator is applicable to all entire functions $y$ the order of which does not exceed a number $\sigma$, where $\sigma \geqslant 1$, if and only if the numbers $a_n$ satisfy the condition

$$\limsup_{n \to \infty} |a_n|^{\frac{1}{n \log n}} < e^{\frac{1}{\sigma} - 1}$$

In case $\sigma > 1$ this condition expresses that $F(z) = \sum_{0}^{\infty} a_n z^n$ is an entire function the order of which is less than $\frac{\sigma}{\sigma - 1}$. In case $\sigma = 1$ this condition express that $F(z)$ is an entire function of finite order. We may also consider 'divergent' operators. Let $F(z) = \sum_{0}^{\infty} a_n z^n$ be divergent for every value of $z \neq 0$. It there divergence is not too rapid, it is possible to show that there exist differential operators $F(D)$ that are applicable to all entire functions $y$ of the normal type $T$ of the order $\sigma$ where $0 < \sigma < 1$.

If the function $f(x)$ is an entire function not exceeding the normal type $b$ of the order 2 and if $a$ denotes a complex number with the property $4\,|a|\,b < 1$, then the differential operator $\phi(D) = e^{aD^2}$ is applicable to the function $f(x)$ and the formula

$$e^{aD^2} f(x) = \frac{1}{\sqrt{\pi}} \int_{-\infty}^{\infty} e^{-u^2} \left((f(x + 2u\sqrt{a})\right) du$$

holds. Further the function $e^{aD^2}\,(f(x)))$ is an entire function.

## 2. G. Bandyopadhyay (Kharagpur) : *Analysis of Creation and Destruction Operator in Second Quantization.*

If a system of elements in space $A$ be mapped on a subspace of another space $B$, then a linear operator on A will correspond to another on $B$; but new operators can be constructed on $B$ which has no corresponding operator on $A$. This simple fact has been looked upon as the basis of second quantization.

## 3. GUNADHAR PARIA (Kharagpur) : *Green's Linear Integral Operator and its Application to Elasticity*

If the function $\bar{K}f$ is defined as

$$\bar{K}f = \int_a^b K(x, t)\, f(t)dt, \tag{1}$$

where $K(x, t)$ is a continuous function of $x$ and $t$ ($a \leqslant x \leqslant b$, $a \leqslant t \leqslant b$), $\bar{K}$ will be called the integral operator which feeds upon $f$ producing the resultant function $\bar{K}f$. It satisfies the linear conditions viz.

$$\begin{aligned} \bar{K}(cf) &= c\, \bar{K}f, \quad \text{where } c \text{ is a constant, and} \\ \bar{K}(f+g) &= \bar{K}f+\bar{K}g. \end{aligned} \tag{2}$$

A class of boundary value problems in mathematical physics consist in solving the difference equation

$$L(y)+\lambda\, s(x)y(x) = h(x) \tag{3}$$

subject to the boundary condition $B(y) = 0$ where $L$ is a linear differential operator and $\lambda$ is the characteristic number for the problem. The corresponding solution $G(x, t)$ of the relaxed boundary value problem (which is unambiguously determinate)

$$L(y) = 0, \qquad B(y) = 0 \qquad x \neq t. \qquad a \leqslant t \leqslant b \tag{4}$$

will be called Green's function for the original problem.

If $K$ and $\bar{K}$ in (1) are replaced by $G$ and $\bar{G}$, the operator $\bar{G}$ will be called Green's integral operator. It is linear and satisfy the relations

$$L\bar{G} = \bar{G}L = -1$$

It reduces the boundary value problem (3) to the solution of the integral equation of Fredholm

$$y(x) = \lambda\, \bar{G}\{s(t)y(t)\}-\bar{G}\, h(t)$$

The solution of the problem of bending of elastic plates under mixed boundary conditions depends upon finding the corresponding Green's functions.

## 4. T. PATI (Allahabad): *Linear Operators in the Theory of Sequence Spaces*

An operator **U**, which is distributive and continuous (that is, $\|\mathbf{U}(x)-\mathbf{U}(x_n)\| \rightarrow 0$ whenever $\|x-x_n\| \rightarrow 0$ as $n \rightarrow \infty$) is called *linear.* The determination of necessary and sufficient conditions that a matrix $A$, defining the transformation: $A(s) = s'$, may map a given sequence space $S$ to another proscribed sequence space $S'$ is one of the central problems in the theory of sequence spaces. The essential result in the necessity part of the Silverman-Toeplitz theorem, which solves this problem for the mapping: $S_c \rightarrow S_c$, that is the space of convergent sequences, amounts to the proposition: $A$ matrix $A$ which transforms $S_c$ into itself is a linear operator. The functional analytic proof depends upon the fundamental convergence theorem with Banach spaces as the operation fields. On proper choice of the norm for a sequence of linear operators, which are assumed to be bounded and to replace the elements of the Matrix A, Robinson (1950) and Melvin-Melvin (1951) have generalised the Silverman-Teoplitz theorem to the case of the transformation: $S \to S$, where $S$ is a Banch space. Zeller (1952) obtains a very simple proof of the same. Wilansky (1951) is able to prove that if $A$ is normal and conservative and the space of bounded sequences: $S_b$ is a $B$-space, then $S_c$ is also a $B$-space, under the norm $\|x\|_A = \sup_n |A_n(x)|$.

The introduction of the notion of $FK$-spaces, which are finitely many—quasinormed sequence spaces with coordinated convergence (Knopp: "Folgenräume etc.", Rome, 1952) by the Tübingen school has had great influence on this entire domain of ideas. A typical result, due to Zeller (1951), of such techniques is contained in the theorem that an intersection of an infinite sequence of decreasing matrix methods of summability is usually not equivalent to a matrix method. On the side of the extensions of the Silverman-Teoplitz theorem we have as a typical result: A matrix which transofrms an $FK$-space into another $FK$-space is a linear operator.

The necessity part of Silverman-Toeplitz theorem can be derived from the theorem of Banch: If $S$ and $S'$ are Banch-spaces, and $\{U_n\}$ is a sequence of linear operators on $S$ to $S'$ such that lim $\sup_n \|U_n(s)\| < \infty$ for each $s \varepsilon S$, then lim $\sup_n \|U_n\| < \infty$. This has led to more detailed treatment of the 'boundedness-problem': to charactorise those triples S, $S'$ and $X$ such that lim $\sup_x \|U_x\| < \infty$ if lim $\sup_x \|U_x(s)\| < \infty$ for each $s \varepsilon S$, by M. M. Day (1942) who takes $X$ to be a directed set of elements $x$.

The dichotomy of summability matrices into those that are multiplicative $m = 0$ and those that are ultiplicative $m \neq 0$ is well-known to be significant. Recently Wilansky (1949) has extended this classification, with the help of Mazur's theorem and results on Banch linear functionals, to the whole set of conservative matrices. He attains the dichotomy into coregular and conull matrices, inducing the same division for multiplicative matrices. A typical result is that if A, B are conservative, with $A$ normal, and $(A) \subseteq (B)$, then if $A$ is conull, so is $B$.

### 5. H. M, SNNGUPTA (Calcutta) : *Linear operation in abstract Hilbert space.*

An abstract Hilbert space **H** is characterized by the following properties :

(1) It is linear, (2) There is an inner product which furnishes a metric, (3) In the metric, $H$ is separable, (4) $H$ is complete, (5) $H$ has an infinity of dimensions.

Hilbert victor space $\sigma_2$ and Hilbert function space $\sigma_2(f)$ are examples of $H$.

Let $\alpha$ be a linear operator of $H$ and $D_\alpha$, $V_\alpha$ be the domains of definitions and values of $\alpha$ respectivefy. Also let $(e,e')$ be the metric function of $H$ for all pairs of elements $e$, $e'$ of $H$.

Then, we have the following properties.

(1) If $\alpha$ is continous at one point of $D_\alpha$, is contineous throughout $D_\alpha$ and the continuity is uniform.

(2) A necessary and sufficient condition that $\alpha$ is continuous is that it is bounded.

(3) $\alpha$ is called unitary if

(i) $D_\alpha = V_\alpha = H$, (ii) $(\alpha(e), \alpha(e')) = (e,e')$.

The class of all unitary operators form a group.

### 6. SHANTI NARAYAN (Delhi) : *Linear operators in Banach space.*

1. Linear spaces. Normed linear spaces. Banach spaces as complete Normed linear spaces. The sets of real and complex numbers as Banach Spaces.

2. Casper Goffman's result concerning the possibility of equipping a given linear space with the structure of a Banach Space (Bulletin of the American Mathematical Society, Vol. 49, 1943, pp. 611-615).

3. Linear operators. Bounded linear operators and their different characterisations. Norm of a bounded linear operator. The set of bounded linear operators equipped with the structure of a Banach space.

4. The set of linear bounded Functionals and the adjoint space of a Banach space.

5. Different concrete sequence and function Banach spaces and their adjoint space.

6. Contribution of the study of the concept of Banach spaces to classical Analysis in relation to the principles of uniform boundedness and of the condensation of singularities.

7. The role of linear operators in the development of Analysis in Banach spaces. Extension of classical Function Theory with [the help of the principle of uniform boundedness and the fact that the vanishing of all functionals of an element of a Banach space implies that the element vanishes. (Bulletin, Vol. 49, 1953, pp. 652-669.

8. The normed linear algebra of linear operators from a Banach space into itself.

9. Study of the spectrum of a linear operator from a Banach space into itself.

10. Resolvent equation.

## III. Riesz Summability and Its Applications

*Chairman* : DR. B. N. PRASAD.

### 1. T. PATI. (Allahabad) : *The Theorems of Consistency in the Theory of Riesz Summability*

Using the standard notation of set-inclusion $\subset$, we mean by '$P \subset Q$' that summability $P$ implies summability $Q$. The 'first theorems of consistency' for ordinary and absolute Riesz summability state respectively that $(R, \lambda, k) \subset (R,\lambda,k')$ and $|R,\lambda,k| \subset |R,\lambda,k'|$, for every $k' > k \geqslant 0$. These theorems amount to the assertions that the 'power or 'efficiency, of a Riesz method, whether ordinary or absolute, increases along with the ' order' if the 'type' remains unaltered, and thus ultimately establish the 'regularity' and 'absolute regularity' of Riesz means of the same type. There naturally arises the question as to whether anything can be said about the relative efficiency of any two Riesz methods of which the types are different while the orders are identical The first answer to such a question is the classical 'second theorem of consistency' to the effect that $(R,\lambda_n, k) \subset (R, \log \lambda_n, k)$, $k \geqslant 0$, due to Hardy and Riesz (The General Theory of Dirichlet's Series, Cambridge, 1952). This theorem was extended by Hardy (Proc. London Math. Soc., 1916) to the result that $(R, \lambda, k) \subset (R,\mu, k)$, $k \geqslant 0$, where $\mu$ is a 'logarithmico-exponential' function of $\lambda$, such that $\mu = 0(\lambda^{\Delta})$, $\Delta$ being some finite constant. In 1932 Hirst further generalised (Proc. London Math. Soc.) this result by replacing $\mu$ by a more general function of $\lambda$ : $\varphi(\lambda)$, and established that, under certain conditions satisfied by $\varphi(t)$, $t \geqslant 0$, $(R, \lambda_n, k) \subset (R,\varphi(\lambda_n), k)$. It has been recently shown by Kuttner (Jour. London Math. Soc., 1951) that, in the case in which $k$ is an integer, Hirst's conditions, which are not only sufficient, but necessary, can be put in the form of the single condition:

$$(*) \qquad \int_A^{\omega} t^k |\varphi^{(k+1)}(t)| \, dt = 0[\psi(\omega)].$$

Kuttner acutally demonstrates with the help of a negative example that if (*) is false, it is possible to find a sequence $\{\lambda_n\}$ and a series which is summable $(R, \lambda_n, k)$ but whose $(R, \psi(\lambda_n), k)$-means are unbounded. For the case in which $k$ is non-integral Kuttner shows (Jour. London Math. Soc., 1952) that (*), with $\varphi^{(k+1)}(t)$ replaced by the fractional derivative $D^{k+1}\varphi(t)$, is neither necessary nor sufficient for the result: $(R, \lambda_n, k) \subset (R, \varphi(\lambda_n), k)$. He has obtained a necessary and sufficient condition to cover both integral and non-integral values of $k$, but these turn out to be less satisfactory than (*) in the case in which $k$ is integral.

The direct analogue for *absolute* summability of Hardy's second theorem of consistency was proved by Chandrasekharan (Jour. Indian Math. Soc., N. S., 1942) who thus confined the type $\mu$ to a very special class of logarithmico-exponential functions of $\lambda$. Recently Pati (Quarterly Jour. Math., Oxford, 1954) proved the following generalisation of Chandrasekharan's theorem in the case in which $k$ is an integer.

If $\varphi(t)$ is a non-negative, monotonic increasing function of $t$ for $t > 0$, steadily tending to infinity as $t$ tends to infinity, such that, for positive integral $k$, $\varphi(t)$ is a $(k+1)$th indefinite integral for $t \geqslant 0$, and

(**) $$t^r \varphi^{(r)}(t)/\varphi(t) \varepsilon BV(h, \quad) \quad (r = 1, 2, .., k),$$

where $h$ is a finite positive number, then any infinite series which is summable $|R, \lambda_n, k|$ is also summable $|R, \lambda_n, k|$.

Prasad and Pati have obtained a parallel theorem for the case in which $k$ is non-integral and $\varphi^{(1)}(t)$ is a monotonic, non-decreasing function of $t$ (Announced in Proc. International Congress of Mathematicians, Amsterdam, 1954), and have still more recently generalised all these previous theorems (See Abstract of paper by Prasad and Pati: "On the theorems of consistency for absolute Riesz summability" in the Proc. Indian Science Congress, Current Session, 1956). For instance, in the generalised version of Pati's theorem the conditions (**) are replaced by the less stringent conditions:

(**)′ $$t\varphi^{(1)}(t)/\varphi(t) \varepsilon BV(h, \infty)$$

and

(**)″ $$t^r\varphi^{(r)}(t)/\varphi(t) \varepsilon B \ (h, \infty) \quad (r = 2, 3, .., k),$$

where $h$ is a finite positive number.

Prasad and Pati (loc. cit.) have also considered the problem of unifying the first and second theorems of consistency for Riesz summability, which arises when we ask as to what can be said about the relative effectiveness of any two methods of Riesz summability that are defined by different types and orders. By virtue of the first theorem of consistency for absolute Riesz summability, we have $|R, \lambda_n, k| \subset |R, \lambda_n, k'|$ for all $k' > k$, under the conditions (**)′ and (**)″, in the case in which $k$ is an integer. Prasad and Pati have demonstrated that the same conclusion can be asserted under the less stringent conditions:

(**)‴ $$t^r\varphi^{(r)}(t)/\varphi(t) \varepsilon B(h, \infty) \quad (r = 1, 2, .., k),$$

where $h$ is a finite positive number, and have thus estabilished the first 'unified theorem of consistency' for absolute Riesz summability.

## 2. SULAXANA KUMARI (Allahabad) : *Applicztion of Riesz Summability to Trigonometrical Series*

1.1. Let $\lambda_n$ be a positive steadily increasing function of $n$, tending to infinity with $n$, and let

$$A_\lambda(\omega)=A^0_\lambda(\omega)=\sum_{\lambda_n\leqslant\omega} a_n,\quad A^r_\lambda(\omega)=\sum_{\lambda_n<\omega}(\omega-\lambda_n)^r a_n,\quad C_\lambda(\omega)=A^r_\lambda(\omega)/\omega^r,\ r>0.$$

The series $\sum\limits_1^\infty a_n$ is said to be summable $(R, \lambda, r)$, $r>0$, if $\lim\limits_{\omega\to\infty} C^r_\lambda(\omega)$ exists and is finite (Riesz, Comptes Rendus, 149, 1909, 308-312). If $C^r_\lambda(\omega)$ is a function of bounded variation in $(A, \infty)$, where $A$ is a finite positive number, then the series $\sum a_n$ is said to be absolutely summable $(R, \lambda, r)$ or summable $|R, \lambda, r|$ (Obrechkoff). Math.. Zeitschrift, 30, 1929, 375-386).

Let $f(\theta)\epsilon L$ over $(-\pi, \pi)$ and periodic outside this range with period $2\pi$. Let

$$f(\theta)\sim\frac{a_0}{2}+\sum_{n=1}^{\infty}(a_n\cos n\theta+b_n\sin n\theta)=\frac{A_0}{2}+\sum_{n=1}^{\infty}A_n(\theta). \tag{1}$$

Then the series conjugate to the above Fourier series is

$$\sum_{n=1}^{\infty}(b_n\cos n\theta-a_n\sin n\theta)=\sum_{n=1}^{\infty}B_n(\theta). \tag{2}$$

The $r$-th derived series of the Fourier series (1) and its conjugate series (2) are

$$\sum_{n=1}^{\infty}\frac{d^r}{d\theta^r}A_n(\theta) \quad\text{and}\quad \sum_{n=1}^{\infty}\frac{d^r}{d\theta^r}B_n(\theta). \qquad (3) \text{ and } (4)$$

respectively.

### 1.2. *Summability by Riesz's exponential means of Fourier series and its associated series*

A very general summability criterion, including results of Wang (Proc Lond. Math. Soc., 47, 1942, 308-325, Thm. 1) and Sinvhal (Proc. Banaras Math. Soc., 8, 1946 11-24), as particular cases, is obtained by Jurkat (Math. Zeitschrift, 53, 1950, 309-339) wherein he has proved that if $(i)\lambda(\omega)$ be continuous, $\lambda(w)>0$, $(ii)\lambda(w)/\lambda'(w)=\Lambda(w)\to+\infty$, as $\omega\to\infty$; $(iii)\lambda'(w)=\lambda(w)/\Lambda(w)\to$ as $w\to\infty$, and if

$$\text{(iv)} \qquad \int_0^t|\phi(u)|\,du=o(t),$$

as $t\to 0$, where $\phi(t)=\frac{1}{2}\{f(x+t)+f(x-t)-2s\}$, then a necessary and sufficient condition that (1) may be summable $(R, \lambda, k)$, $k>0$, at $\theta=x$, to sum $s$, is that

$$\int^{1/(\omega)\Lambda}\phi(t)\frac{\sin\omega t}{t}\,dt=0(1),$$

as $w \to \infty$. Jurkat also proved that if the conditions (i) to (iv) are satisfied and if (1) is summable $(R, \lambda, k)$, for some $k > 0$, at $\theta = x$, to sum $s$, then it is summable $(R, \lambda, k')$, to sum $s$, for every $k' > 0$. He has also obtained the analogous results for the conjugate series.

For the summability of the type $e^{(\log \omega)^{\beta}}$, $\beta > 1$, Wang (Proc. Lond Math. Soc., 51, 1950, 215-231) has proved that if $(\alpha)$ $\varphi_{\alpha}(t) = 0(1/\log \frac{1}{t})$, as $t \to 0$, for $\alpha > 0$, where

$$\phi_{\alpha}(t) = \frac{\alpha}{t^{\alpha}} \int_{0}^{t} (t-u)^{\alpha-1} \phi(u) du,$$

then (1) is summable $(R, e^{(\log \omega)^{1+\frac{1}{\alpha}}}, \alpha+1)$, at $\theta = x$, to sum $s$. It is however conjectured that the order of summability in the above result can be reduced from $\alpha+1$ to $\alpha+\delta$, for $\delta > 0$. This modification for the case $\alpha = 1$ was effected by Wang (Journ. Lond. Math. Soc., 18, 1943, 155-160).

It was been shown by Sulaxana Kumari (Abstracts, Proc. Current Session Indian Sc. Congress) that if '0' in condition $(\alpha)$ is replaced by '0' and a further condition

$$(\beta) \qquad \int_{0}^{t} |\phi(u)|\, du = 0(t),$$

as $t \to 0$, is added, then the order of summability in the above result of Wang is reduced from $\alpha + 1$ to any $\delta > 0$.

For the summability $|R, e^{(\log)^{1+1/\alpha}}, \alpha+\delta|$, for integral values of $\alpha \geqslant 1$, of series (1) to (4) at $\theta = x$, very general theorems are recently established by Pati (Prod. Indian Sc. Indian Congress III, 42nd Session 1955) including some previously obtained results of Mohanty (Proc. Lond. Math. Soc., 52, 1951, 295-320), Matsuyama (Tohoku Math, Journ., 3, 1951, 39-44) and Pati (Bull. Cal Math. Soc., 44, 1952; Trans. Amer. Math. Soc., 1954, 351-374) as particular cases.

Connsidering the sunmability of the type $e^{\omega^{\alpha}}$, $0<\alpha<1$, Wang (Journ. Lond Math. Soc., 17, 9142, 98-107) proved that if $\phi_{\beta}(t) = 0(t^{\gamma-\beta})$, $\gamma > \beta > 0$, then (1) is summable $(R, e^{u(1-\beta/\gamma)}, \tau)$, to sum $s$, at $\theta = x$, for every $\tau > \gamma$. The analogous result for the summability of the conjugate series, for the case $\beta = 1$, has been obtained by Sulaxana Kumari (Proc. Ind. Sc. Congress, 41st Session, 1954). She has also obtained some results on the Riesz summability of conjugate series analogous to those obtained by Wang (Journ. Lond. Math. Soc. 18, 1943, 155-160; Duke Math. Journ., 11, 1944, 435-439) for the case of Fourier series.

Mohanty (Proc. Lond. Math. Soc., 52, 1951, 295-320) has obtained some results on the summability $|R, e^{\omega^{\alpha}}, 1|$, $0<\alpha<1$, and $|R, e^{\omega(\log\omega)^{-\beta}}, 1|$, $\beta = 1 + \frac{1}{\delta}$, $\delta > 0$, of Fourier series and its associated series.

### 1.3. *Logarithmic summability of Fourier series and its associated series*

It was first proved by Hardy (Quart. Journ. Math., 1931, 107-112) that if

$$(a) \qquad \int^{t} |\phi(u)|\, du = 0\left(t \log \frac{1}{t}\right)$$

as $t \to 0$, then a necessary and sufficient condition that the Fourier series (1), at $\theta = x$, may be summable ($R$, log $n$, 1), to sum $s$ is that

$$\int^{\pi} \frac{\phi(u)}{u}\, du = 0\left(\log \frac{1}{t}\right)$$

as $t \to 0$. Takahasi (Proc. Physico Math. Soc. Japan III, 15, 1933, 181-183) improved the above result by replacing the condition (a) by

$$\text{(b)} \qquad \int^{t} |\phi(u)|\, du = 0\left(t \log \frac{1}{t}\right), \quad \text{as } t \to 0,$$

and

$$\text{(c)} \qquad \int^{t} \phi(u) du = o\left(t \log \frac{1}{t}\right), \quad \text{as } t \to 0.$$

The generalization of the above result for the summability ($R$, log $n$, $k$), of (1) has been obtained by Wang (Tohoku Math. Journ., 40, 1935, 142-159) for integral values of $k>0$, and of (2) by Misra (Proc. Nat. Inst. Sc. India, 13, 1947, 157-168), for any $k > 0$.

Writing

$$\bar{\Phi}_{\alpha}(t) = \frac{1}{\Gamma(\alpha)} \int^{\pi} \left(\log \frac{u}{t}\right)^{\alpha-1} \frac{\phi(u)}{u}\, du, \quad \bar{\phi}_{\alpha}(t) = \frac{\Gamma(\alpha+1}{(\log \frac{1}{t})^{\alpha}}\, \bar{\Phi}_{\alpha}(t), \ \alpha > 0,$$

Wang (Tohoku Math, Journ., 40, 1935, 274-282), has proved that if $\bar{\bar{\phi}}_{\alpha}(t) = 0(1)$ $\alpha > 0$, as $t \to 0$, then (1) is summable ($R$, log $n$, $\alpha+\delta$). $\delta>0$, at $\theta = x$, to sum $s$. Conversely if (1) is summable (R, log $n$, $\alpha$), $\alpha>0$, at $\theta = x$, to sum $s$, then $\bar{\phi}_{\alpha+1\delta}(t) = o(1)$, as $t \to 0$. The analogous results for the summability of the conjugate series have also been obtained by Wang (Tohoku Math. Journ., 40, 1935, 393-397).

Relations between the ($c$, $k$) means of ($t$) and the ($R$, log $n$. $k$) means of (1) has been obtained by Wang (Duke -Math. Journ., 15, 1948, 5-10) and Sunouchi (Tohoku Math., 3, 1951, 114-122).

For the determination of the jump of a function by means of its Fourier series applying Logarithmic means results have been recently obtained by Misra (Quart. Journ., 18, 1947, 147-156) and Matsuyama (Journ. Math. Soc. Japan, 1950, 212-218).

For the summability (R, log $n$, $k$) of (3) and (4), generalizing and covering the results of Wang (Tohoku Math. Journ., 40, 1935, 237-240), Matsuyama (Tohoku Math. Journ., 1, 1950, 91-94), Sunouchi (Tohoky Math. Journ., 3, 1951, 71-88), Mohanty and Nanda (Quart. Journ., 6, 1955, 63-58), a nd Misra (Saugar Univ. Journ., 1, 1952, 197-207), Sula xana Kumari has proved (in an unpublished paper) that if ($R$, log $w$, $\delta$) means, for $\delta \geqslant 0$, of the Fourier series associated with $g(t)$, at $t = 0$, be $o(\log w)^{r}$, as $w \to \infty$, and if it be summable ($R$, log $w$, $r+\delta$), to sum $s$, then (3) is summable ($R$, log $w$, $r+\delta$), to sum $r!s$, at $\theta = x$, where $g(t)$ is the $r$-th generalized derivative of $f(\theta)$, at $\theta = x$, and is supposed to be integrable $L$, the analogous result for the summability of (4) being also obtained. Also the generalization of a result of Mohanty and Nanda (Proc. Ind. Sc. Congress, III, 43rd Session, 1955), regarding the behaviour of the Logarithmic means of (4), for $r = 1$, has been obtained by her for $r \geqslant 1$.

Regarding Absolute Logarithmic summability of Fourier series, improving a result of Izumi and Kawata (Tohoku Math. Journ., (1), 45, 1938, 134-144), Izumi and Matsuyama (Math. Japonicae, 1, 1949, 140-150) have proved that if $\bar{\phi}_s(t) = O\left\{\left(\log \frac{1}{t}\right)^{-\varepsilon}\right\}$ for any $\varepsilon > 0$ then the Fourier series of $\phi(t)$, at $t = 0$, is summable $|R, \log n, s+1|$, for $s > 0$. For $s = 0$ it has been stated by Matsuyama (Tohoku Math. Journ., 3, 1951, 39-44) that if $\phi(t)\left(\log \log \frac{1}{t}\right)^{\beta} = O(1)$, $\beta > 1$, as $t \to 0$, then (1), at $\theta = x$, is summable $|R, \log n, 1|$.

Prasad and Misra (Proc. Ind. Sc. Congress, IV, 40th Session, 1953) have proved that if $\phi_a(t)$ is of bounded variation in $(0, \pi)$, then (1), at $\theta = x$, is summable $|R, \log n, \beta|$, for $\beta > a+1$, $a \geqslant 0$.

Mohanty and Mahapatra (Proc. Ind. Sc. Congress, III, 42nd Session, 1955) have proved that if $\bar{\phi}(t)/\log\left(\frac{k}{t}\right)$ is $BV$ in $(0, \pi)$, then (1) is summable $|R. \log n, 2|$ at $\theta = x$, and if $\theta(t)/\log\left(\,k\,\right)$ is $BV$ in $(0, \pi)$ then (3), for $r = 1$, is summable $|R. \log n, 2|$, at $\theta = x$, where

$$\theta(t) = \tfrac{1}{2} \int_t^{\pi} \{f(x+t) - f(x-t)\}\, t^{-2} dt.$$

Sounouchi (Tohoku Math. Journ., 3, 1951, 114-122) has tried to find out a relation between the $|C, \alpha|$ means of $\phi(t)$ and $|R, \log n, \alpha|$ means of Fourier series (1), at $\theta = x$.

Izumi (Tohoku Math. Journ., 1, 1950, 136-143) and Mohanty (Journ. Lond. Math. Soc., 25, 1950, 67-72) have independently proved that the summability $|R, \log n|$ is not a local property of Fourier series.

There however still remains considerable scope of investigation in the domain of Absolute Logarithmic summability of Fourier series and its associated series.

### 3. (Kumari) PRAMILA SRIVASTAVA (Allahabad) : *Riesz Summability of Dirichlet Series and the Theory of Strong Rieszian Summability*

The series

$$\sum^{\infty} a_n e^{-\lambda_n s}, \tag{1}$$

where $\{\lambda_n\}$ is a sequence of real increasing numbers whose limit is infinity, $s = \sigma + ti$ is a complex variable whose real and imaginary parts are $\sigma$ and $t$, is called a Dirichlet series of type $\lambda_n$. When $\lambda_n = \log n$, the series (1) is called an ordinary Direchlet series. The series (1) is also written in another way as

$$\Sigma\, a_n l_n^{-s},$$

where $\{l_n\}$ is used to denote $e^{\lambda_n}$.

The first applications of Riesz summability to Dirichlet series were made by Riesz (Comptes Rendus 1909), and its special effectiveness for problems concerning these series was pointed out. Subsequently the existence of the abscissae of summability $(R, \lambda, k)$ and summability $(R, l, k)$, their equivalence and the commonvalue, the asymptotic behaviour of the sum function $f(s)$ of the Dirichlet seres to the right of the line of summability $\sigma_k$ and other properties of $f(s)$ were investigated. Results were given in which starting with certain restrictions on the Reisz sum of $\Sigma\, a_n$ and on the benaviour of $f(s)$ on the line of summability $\sigma_k$, summability of order $k$ at some points of the line

$\sigma = \sigma_k$ is obtained, and also others in which summability by Riesz means of sufficiently high order in a half plane coupled with the regularity of the analytic function $f(s)$ in a greater half plane is shown to yield $k$-order summability in the extended region, (Hardy & Riesz's The General Theory of Dirichlet Series' Cambridge Tract 1915; and Chandrasecharan and Minakshisundaran, 'Typical Means' 1952).

The properties of $\sigma_k$ considered as a function of $k$ were first investigated by Bohr (Gottinger Nachrichten, 1909) for ordinary Dirichlet series. More precise theorems obtained by Hardy and Littlewood were extended by Riesz (Acta Szeged 1, 1923) so as to apply to the most general type of Dirichlet series. In particular, he proved that $\sigma_k$ is a convex function of $k$. Converse theorems on the abscissae of summability-Tauberian in nature-have been considered by Hardy & Littlewood, Ananda Rau and others (Typical Means loc. cit).

Tauberian theorems, which consist of results obtained in the attempt of solving the problem of finding additional conditions, which, together with the assumption that $f(s)$ tends to a finite limits as $s \to 0$, would assure the convergence of $\Sigma a_n$;, have been proved by Hardy & Littlewood, Ananda Rau znd Szasz (Typical Means, loc cit). A result of similar nature has also been given by Garabedian (Bull. Amer. Math. Soc., 45, 1934) which may be stated as follows.

If $\lim_{s \to 0} \sum_{n=1}^{\infty} a_n e^{-\nu_n s}$ exists, then $\Sigma a_n$ is summable $(R,\lambda,1)$ provided that $\nu_n$ is a logarithmico-exponential function of $\lambda_n$ which tends to infinity with $n$ but not as slowly as log $n$ nor faster than $\lambda_n^{\Delta}$ where $\Delta$ is any positive constant however large.

The notion of absolute Riesz summability was introduced and also the absolute summability of Dirichlet series investigated by Obreschkoff (Math. Zeitschrift, 30 1929). He established the existence of the abscissae $\bar{\sigma}_k$ of summability $|R,\lambda, k|$ and evaluated it. Theorems connecting the abscissae of summability, ordinary and absolute, of the Dirichlet series (1) have been given by Bosanquet (Journ. Lond. Math. Soc., 22, 1947 & 23, 1938), Austin (Jour. Lond. Math. Soc. 27, 1952) and Borwein (Jour Lond. Math. Soc., 30, 1955). The identity of the abscissae f summability corresponding to the methods $|R,\lambda, k|$ and $|R, l, k|$ has been recently established by Tatchell (Jour. Lond. Math-Soc., 29, 1954). The properties of $\sigma_k$ considered as a function of $k$ are still to be investigated.

The only property of $f(s)$, obtained with reference to its summability $|R,\lambda,k|$, is one regarding its asymptotic behaviour to the right of the line $\sigma_k$ due to Obreschkoff (loc. cit.). The possibility of the existence of other results somewhat similar to those already known in case of sumability $(R, \lambda, k)$ may offer a fruitful line of investigation.

As regards the Dirichlet product of summable series Hardy & Riesz (loc. cit) proved that if the series $\Sigma a_n$ be summable $(R,\lambda, k)$ and $\Sigma b_n$ be summable $(R, \mu, l)$, then the product series $\Sigma c_n$ is summable $(R, \nu, k+l+1)$. Obreschkoff showed that if $\Sigma a_n$ be summable $|R, \lambda, k|$ and $\Sigma b_n$ summable $|R, \mu, l|$, then $\Sigma c_n$ is summable $|R, \nu, k+l|$. Again, one of the results given by Chandrasekharan and Minakshisundaran (loc. cit.) gives that if $\Sigma a_n$ be summable $(R, \lambda, k)$ & $\Sigma b_n$ be summable $(R, \mu, l)$ and also

$\int_0^{\omega} |d\bar{A}_{\lambda}^{k+1}(t)| = 0(\omega^{k+1}), k > 0,$ then $\Sigma c_n$ is summable $(R,\nu, k+l)$.

**It is an interesting and important problem to determine the abscissae of summability of the Dirichlet series $\Sigma c_n e^{-\nu_n \rho}$ knowing those of $\Sigma a_n e^{-\lambda_n s}$ and $\Sigma b_n e^{-\mu_n s}$. For the ordinary Dirichlet series Bohr (Mat. Tidsskr. B, 1950) has established that if $\Sigma a_n n^{-s}$**

is summable $(c, r_1)$ and $\Sigma b_n n^{-s}$ is summable $(c, r_2)$, $r_1 \leqslant r_2$ both for $\sigma > 0$, then $\Sigma c_n n^{-s}$ is is summable $(c, R)$, $0 \leqslant R \leqslant r_1 + r_2 + 1$ for $\sigma > \phi$ where $\phi = r_2 - R$ or $\frac{1}{2}(r_1 + r_2 + 1 - R)$ according as $R + r_1 + 1$ is $\leqslant r_2$ or $> r_2$. He has further shown that this theorem is best of it kind.

Strong Rieszian summability has been defined as follows by P. Srivastava (Abstract, Proc. I. S. C. A. 1955 Baroda). If $\int_\lambda^x dt|c_\lambda^{k-1}(t) - s|^q = 0(x)$, as $x \to \infty$, where $c_\lambda^{k-1}$ is the Riesz mean of order $k-1$ type $\lambda$ associated with the series $\Sigma a_n$, then the series $\Sigma a_n$ is said to be summable $[R, \lambda, k, q]$. Boundedness $[R, \lambda, k, q]$ is similarly defined with $O$ in place of $o$. When $q = 1$, $[R, \lambda, k, q]$ is denoted simply by $[R, \lambda, k]$. The results of Winn (Math. Zeitschrift, 37, 1933), Kuttner (Jour Lond. Math. Soc., 21, 1946) and Hyslop (Proc. Glasgow Math. Assoc., 1, 1952) for strong Cesàro's summability are shown to have their counterparts in the more general theory of strong Rieszian summability. The analogue of Hyslop's result suggests an alternative definition for strong Rieszian summability akin to that given by Boyd and Hyslop (Proc. Glasgow Math. Assoc., 1, 1952) for the particular case $\lambda_n = n$. Their theorem concerning the equivalence of summabilities $[R, k; p]$ and $[C, R; p]$ shows that strong Rieszian summability is a generalization of strong Cesàro's summability in the same sense as summabilities $(R, \lambda, k)$ and $|R, \lambda, k|$ are those of summabilities $(C, k)$ and $|C, k|$ respectively. Summability $[R, \lambda, k, q]$, for $\lambda_n = \log n$, is shown to be identical with strong logarithmic summability of index $q$.

As regards the interconnections between summabilities ordinary, absolute and strong, the results obtained demonstrate that (i) summability $|R, \lambda, k|$ implies summability $[R, \lambda, k]$ or simply $|R, \lambda, k| \subset [R, \lambda, k]$, (ii) $[R, \lambda, k] \subset (R, \lambda, k)$, (iii) $(R, \lambda, k-1) \subset [R, \lambda, k, q]$, and (iv) $[R, \lambda, k, q] \subset (R, \lambda, k-1, \delta)$, where $q > 1$, $kq' > 1$, provided $\delta > \frac{1}{q}$..

The first theorem of consistency for summability $[R]$ asserts that if $\Sigma a_n$ is summable $[R, \lambda, k]$, then it is also summable $[R, \lambda, k+l]$, $l > 0$. The first result in the direction of tackling the converse problem of obtaining lower order summability from sumability $[R, \lambda, k]$ is the analogue of a well known result for $(C)$ summability which states that if $\Sigma a_n$ be summable $(R)$ for any order, then a necessary & sufficient condition for $\Sigma a_n$ to be summable $[R, \lambda, k]$ is that the sequence $\{a_n \lambda_n\}$ be summable $[R, \lambda, k+1]$ to the the sum zero. Another approach to the same problem gives that if the given series be bounded $[R, \lambda, k]$ and summable $(R)$ for some order, then it is also summable $[R, \lambda, k+\delta]$, $\delta > 0$. In case of summability $(R, \lambda, k)$, the corresponding result has been replaced by much more general result known as convexity theorems.

The general result in the direction of assessing the relative effectiveness of any two process of Riesz summability of which the types are different while the orders are identical is termed as the second theorem of consistency. For summability $[R]$ the following direct analogue of Hirst's theorem (Proc. Lond. Math. Soc., (2) 33, 1932) has been given by Srivastava.

If $\phi(t)$ is a non-negative monotonic increasing function of $t$ for $t \geqslant 0$ tending to infinity with $t$, such that for positive integral $k$,

$$\int_0^\omega t^k \, |\varphi^{k+1}(t)| \, dt = 0\{(\omega)\}$$

as $\omega \to \infty$, then any infinite series which is summable $[R, \lambda, k]$ is also summable $[R, \phi(\lambda), k]$.

There arises the natural question whether anything can be said about summability $[R, \lambda, k]$ of an infinites eries being given its summability $[R, \varphi(\lambda), k]$. A result, by way of answering the corresponding question for summability $(R)$ was given by Hardy & Riesz (Th. 20, loc.cit.) Its analogue for summability $(R)$ has been proved by Tatchell (loc. cit). Srivastava has established the corresponding theorem for summability $[R]$.

Concerning the strong Riesziansummability of Dirichlet series, results have been announced in the abstract of a paper on strong summability of Dirichlet seres (Proceedings of the current session of the Indian Science Congress) In case of power series, circle of convergence, circle of absolute convergence and circle of regularity of the sum function are all the same. In the theory of Dirichlet series, where circle is replaced by half plane the three corresponding half planes may be all different. The half planes of summability and absolute summability may be different. But when strong summability is considered instead of ordinary summability it is seen that the half planes of summability $[R, \lambda, k]$ and summability $|R, \lambda, k$ are the same.

For Cauchy's product of summable series Winn (loc. cit.) proved that if $\Sigma a_n$ is summable $[C, R]$ and $\Sigma b_n$ is summable $(C, l)$ then the product series is summable $(C, k+l)$, $(k > 0, l \geqslant 0)$. The last result quoted in connection with Dirichlet product of summable series is precisely the analogue of this theorem for the Dirichlet product. That if $\Sigma a_n$ is summable $|R, \lambda\, k]$ and $\Sigma b_n$ is summable $|R, \mu, l)$, then $\Sigma c_n$ is summable $[R, \nu, k+l]$ can also be easily proved.

## IV. Teaching of Mathematics in Engineering Institutions.

*(Jointly with Sections of Engineering and Statistics)*

*Chairman:* DR. B. R. SETH

In the 42nd Session of the Indian Science Congress at Baroda the symposium on 'Teaching of Mathematics in Engineering Institutions' was held jointly by the section of Mathematics, Engineering Science and Statistics. Dr. U. S. Nair, opened the symposium and Prof. B. R. Seth, Dr. A. K. Gayen. Dr. C. Prasad, Prof. G. Pickett, (Wisconsin, U.S.A.), Prof. A. C. Ingersol (C.I.T., U.S.A.). Prof. B. D. Puri, Prof. S. V. P. Aiya and Sri S. L. Kumar and Dr. M. K. Ganguli spoke on the subject and participated in the deliberations and discussions of the meeting. The speakers were almost unanimous in their views that the present syllabi in Engineering Colleges would require urgent revision and that there should be uniformity in this respect in Engineering and Technological Colleges all over the country. Before taking immediate steps in this connection it was considered necessary to give sufficient time to the teachers concerned and to appoint a sub-Committee for a detailed study into the present curricula and for preparing draft syllabuses for various engineering and technological courses, and further that such a Committee should go into the nature and extent of courses to be taught both at the under-graduate and Post-graduate levels.

Accordingly the Joint Meeting of the Sections appointed a sub-Committee of three engineers, two mathematicians, and two statisticians with Professor B. R. Seth, as the convener, to go into details of the matter and to report to the next Joint Meeting of the Sections at the session of the Congress in Agra 1956. The personnel of the Committee are as follows :—

1. Prof. B. R. Seth (Khargpur), Convenor
2. Prof. B. D. Puri (New Delhi), Secretary

3. Prof. S. V. C. Aiya (Poona), Engineer
4. Dr. A. K. Gayen (Khargpur), Statistician
5. Dr. M. K. Ganguli (New Delhi), Statistician
6. Dr. C. Prasad (Roorkee), Mathematician
7. Sri S. L. Kumar, Director of Research, Rly. Research Center, Alam Bagh, Lucknow.

In reply to request letters issued by Professor B. R. Seth, to engineers, mathematicians and statisticians in the field the following communications were received from Dr. C. Prasad (Roorkee), Dr. S. V. C. Aiya (Poona), Dr. R. Ballabh, (Lucknow), Dr. M. K. Ganguli and Dr. A. K. Gayen on the details of suitable syllabus on Mathematics.

### 1. C. PRASAD (Roorkee) : *Outlines of a syllabus in Mathematics for Undergraduate and Post-graduate courses in Engineering*

#### COURSE FOR B.E.

*Calculus*—Differentiation and application to rates, approximation Max. and Min., Expansions. Partial Differentiation.

Integration and applications to areas, volumes, C.G. etc.

*Differential Equation*—Simple 1st order 1st degree equation. Linear with const. coefficients.

*Algebra and Trigonometry* Convergence, Determinants, Complex nos including De Moivre's theorem. Graphical and Numerical solution of equations.

*Coordinate Geometry of 3 dimensions*—Planes, st. lines and spheres.

*Mechanics and Hydrostatics.*

#### POST GRADUATE COURSE

Solution of equations in Series. Legendre, Bessel, Gamma functions. Elliptic Integrals. Vector Analysis. Function of a Complex Variable. Partial Differential Equations.

Numerical Methods, Statistics.

Selected topics according to course from

Elasticity, Hydrodynamics, Laplace transform and Circuits, etc.

(Naturally, in the post-graduate courses the time will not allow a deep study of the topics mentioned, only a knowledge of the elements is intended).

### 2. S. V. CHANDRASEKHAR AIYA (Poona) : *Courses in Mathematics for Intermediate Science and Engineering Students.*

#### OUTLINES OF A TWO-YEAR MATHEMATICS COURSE FOR INTERMEDIATE SCIENCE STUDENTS.

#### PART I

*Trigonometry*—Circular Measure. Orthogonal projection as required for defining trigonometric functions of any angle. Trinogometric functions of any angle. Simple trigonometric equations. Inverse trigonometric functions. Addition formulae for two angles. Graphs of sin , cos etc. Solution of tringles. Use of trigonometric tables.

*Geometry*—Theorems pertaining to (*a*) proportion—similar triangles, (*b*) Concurrency and Collinearity and (*c*) Radical Axis.

*Solid Geometry*—Eelementary properties of lines, planes, pyramids, prisms, cones, cylinders and spheres. Surfaces and volumes of parallelopipeds pyramids, cones, cylinders and spheres by the methods of the Calculus preferably

*Analytical Geometry*—Meaning of a graph. Equations of a straight line, a pair of straight lines and circle. Equations of the parabola, ellipse and hyperbola (referred to their principal axes). Simple tangent and normal properties of these curves. Properties relating to parallel chords, pairs of tangents etc., are not required except for the circle.

## PART II

*Algebra*—Indices, surds, logarithms with applications. Quadratic equations, simultaneous equations involving quadratics and graphical illustrations. Definition and use of simple Determinants of second and third orders. Quadratic expressions and graphs. Remainder theorem. Progressions. Simple permutations and combinations. Summation of squares positive integral index.

*Calculus*—Simple ideas and properties of limits. Differentiation of simple functons, second differential co-efficient. Notion of differentials and its application to numerical approximations. Maxima and minima and their discrimination, application to the tangent and normal properties of simple curves.

Integration as the inverse of differentiation, integration of simple functions, integration by substitution and integration by parts, definition of a definite integral as the limit of a sum and the application to simple cases of areas and of volumes of solids of revolution.

## OUTLINES OF A FOUR-YEAR MATHEMATICS COURSE FOR BACHELOR OF ENGINEERING STUDENTS.

## PART I

(a) *General Mathematics* —

Determinants and their application to the solution of simultaneous algebraic linear equations and eliminations.

Solution of algebraic equations with special reference to cubic and quadratic equations. Newton's and Horner's methods of approximating the roots of an equation. Application of graphs for solutions of equations and determination of laws from experimental data.

Complex number and their graphical representations. De-Moivre's theorem. Hyperbolic functions. Separation of real and imaginary parts.

Reduction of general equations of the second degree.

Rectangular Co-ordinates in space. Direction-cosines of a line. Equations of planes and straight lines. General ideas about the surface—a cone, a cylinder. A curve in space with ideas about the normal, binormal and tangent.

(b) ***Statistics***—

Classification and tabulation of measurements. Graphical representation of data. Histograms. Frequency polygons and frequency curves. Averages and other measures of location. Measures of dispersion, Moments and measures of skewness and kurtosis. Normal distribution. Standard errors. Simple curve fitting. Method of least squares. Application of nomography to engineering problems.

(c) *Differential Calculus*—

Study of curves (Cartesian and polar co-ordinates).

Curve tracing and characteristic properties with sperical reference to logarithmic and trigonometric curves, cycloid, catenary witch, lemmiscate, cardiode, semi-cubical parabolas and spirals. Lengths of tangent and normal, lengths of sub-tangent and sub-normal, centre and radius of curvature for curves in different systems of co-ordinates.

Taylor's and Maclaurin's theorems without proofs for the expansion of functions in series and their applications to derive approximate values of functions.

(d) *Partial differentiation*—

Applications to errors and approximations. Maxima and minima of implicit functions. Functions of connected variables and functions of two independent variables. Legrange's method for several independent variables.

## PART II

(a) *Integral Calculus*—

Reduction formulae *viz.*,

Double and triple integrals.

Areas of curves, rectification of plane curves, volumes and surfaces of revolution, centre of gravity. Pappus theorem. Moment of itertia and mean values. Determination of centre of pressure.

Approximate integration -Simpson's rule for areas and volumes.

(b) *Periodic functions*—Fourier series.

(c) *Differential equations*—Equations of the first order and first degree-variables separable, exact equations and linear equations with applications to electrical engineering.

Equations of the first order and higher degree.

Linear equations of higher order with constant co-efficients.

Partial differential equations with particular solutions of the type of wave equation. Laplace's equation,

(d) *Vector Analysis*—

Fundamental operations such as addition and subtraction of vectors, dot and cross products.

Differential operation of vector and scalar point function. Gradient of scalar point function. Divergence of a vector point function. Gauss's theorem. Curl of a vector point function. Stoke's theorem.

(e) Solution of differential equations in series with simple forms of the type $D^2y + P\,Dy + Q\,Y = 0$ where $P$ and $Q$ are simple function of $x$.

Definition of Bessel's function in the form

$$Jn\,(x) = \frac{1}{2\pi}\int_0^{2\pi} \cos\,(n\theta - x\sin\theta)\,d\theta$$

(f) *Conjugate functions*

(g) *Elasticity*—Stress and strain quadrics. Work and energy stress equation of motion. Stress in isotropic bodies. Non-rotational strain. Pure strain, cylindrical strain, pure torsion. Bending of rods, beams etc,

(h) *Spherical harmonics*- Legendre polynomials.

(i) *Laplace Transforms.*

### 3. R. Ballav (Lucknow) : *Teaching of Mathematics to Engineering Students: Outlines of a Four-year course in Mathematics including Statistics.*

The engineer is essentially an applied mathematician. As such his training has to be based on a model best suited for the purpose. He should have a thorough grounding in the fundamental methods and processes of mathematical thought. As the problems of the real world are often difficult to solve in exact terms, the training should particularly include instruction in methods of approximation.

The student opting for an engineering degree should be made to study Mathematics, Physics, Chemistry and Geology during the first two years of his training. The syllabus in Mathematics should consist of the following subjects :—

1. Vector Methods
2. Differential and Integral Calculus including numerical integration.
3. Differential equations including partial differential equations.
4. Elements of Algebra, Trigonometry and Analytical Geometry of two and three dimensions.
5. Mechanics
6. Elementary Statistics including probability.

At the end of this course the student should decide what type of engineer he would like to be. It may be possible to give him some advice in this direction judging from his performance during this period.

The next two years of his training should include the following syllabus in Mathematics.

1. Laplace's and other transforms.
2. Relaxation methods.
3. Calculus of Observation.
4. Hydro and aero dynamics, (if he is going to be an irrigation or aeronautical engineer).
5. Elasticity, Plasticity and Rheology (if he is going to be an irrigation engineer or mechanical engineer).
6. Applied Mechanics and rigid dynamics (if he is going to be a mechanical engineer).
7. Spherical trigonometry and mathematical astronomy (if he is going to be a naval engineer).
8. Tensor Analysis (particularly if he is going to be an Electrical Engineer).

During this period he should be imparted instruction in other subjects relevant to his requirements. These will be determined by his special choice of career as an engineer.

The full course of training for an engineering student should therefore extend over four years after which period he should be regarded as a fullfledged engineer.

Admission to an engineering course should be made after a student has completed his higher secondary schooling. This will mean that students who have passed their Intermediate Examination of an Indian University or its equivalent will be eligilble to join an engineering college.

### 4. M. K. **GANGULI** (Delhi): *A Syllabus of Mathematics for Engineering Students*

*1st Year and 2nd Year*

Differential Calculus and Integral Calculus.

Limiting values of Functions, Differentiation of algebraic and trigonometrical functions, Maxima and Minima, Geometrical applications -Tangent, Normal, Radius of curvature etc. Successive differentiation. Partial differentiation. Methods of Integration, Standard formulae, Definite Integrals, Simple areas and volumes, geometrical applications (Cartesian and polar co-ordinates). Double integration.

*Co-ordinate Geometry (First Year)*

Equations to straight lines and their properties— Properties of circles and other second degree curves - Transformation of co-ordinates.

*Statics and Dynamics (First Year)*

Forces, Conditions of equilibrium, Centre of gravity- -Work, Energy, Power, Laws of Friction—Virtual work. Velocity, acceleration, Simple Harmonic motion, Projectiles, Moments of Inertia—Motion of a particle in three dimensions.

*Statistics (First and Second Year)*

Elementary methodology—Measures of central tendency, Variation, Correlation etc.—Permutation and combination, elements of Probability. Theory of curve fitting-goodness of fit- -Simple Statistical tests- -Normal curve—Principles of control charts—Elementary notions of Sampling and Inspection Plan.

*Solid Geometry (First and Second Year)*

Properties of planes, straight lines, and simple solids of revolution.

*Differential Equation (Second Year)*

Solution of Linear differential equations—homogeneous and non-homogeneous. General methods of solution -Harmonic motion etc.

*Advance Course (Third Year)*

Harmonic analysis, Fourier's series, application of differential equations for the solution of electrical Network. Numerical Calculus—Interpolation, Approximate integration and differentiation (quadrature), Approximate solution of differential equations etc.

### 5. A. K. **GAYEN** (Kharagpur): *Syllabuses in Mathematics and Statistics for various Engineering Courses*

Development in various branches in Engineering such as mechanical, civil, electrical etc., and particularly those that have come into prominence in the second quarter of this century such as chemical, agricultural, electronics and lastly nuclear engineering has been increasing with the application of mathematical and basic physical sciences. Basic sciences like Mathematics, Physics, Chemistry and Statistics must be subjects of special study for engineering students. There should be well-thought-over curricula for them in all those sciences. The symposium on teaching of mathematics in Engineering Colleges under the Indian Science Congress has laid special stress on the syllabuses, for it is high time that we revise our existing mathematical courses in the Engineering faculties of our universities and colleges. Many of the recent development in mathematics, of which statistics is of a major kind, have been proved to be very fruitful in engineering practice and the students of engineering should no longer be kept ignorant of such techniques.

The following pages give some outlines of the courses in Mathematics and Statistics which may be considered for adoption. They have been prepared on the basis of recommendation of various committees of Scientific Societies both in India and abroad.

## I. FIRST YEAR COURSE IN CIVIL, MECHANICAL, AGRICULTURAL, ELECTRICAL, METALLURGICAL AND NAVAL ENGINEERING.

### MATHEMATICS.

1. *Calculus.* Elementary Functions, limit and continuity, differentiation, successive differentiation, simple expansions, integration treated as an inverse process of differentiation, standard integrals, integration by substitution, integration of parts and by successive reduction, partial differentiation, tangents and normals, maxima and minima, curvature, definite integrals, area under a curve, volumes and surface areas of solids of revolution, lengths of curves, applications to mechanics.

2. *Algebra.* Simple determinants, product of determinants, consistency of equations, applications to the solution of a system of linear equations.

3. *Trigonometry.* Complex numbers, De Moivre's Theorem with important deductions, Gregory's series, simple expansions of powers of sine and cosine, Hyperbolic functions, summation of trigonometric series.

4. *Analytical Geometry of Two dimensions.* Co-ordinates, areas of triangles and polygons, equations of the straight line, change of axes, standard equations of the conic sections, equations of the tangent, normal, pole and polar and diameter of conics represented by the general equation of the second degree, reduction of the general equation of the second degree, curve tracing (methods of calculus to be used).

5. *Differential Equations.* Formation and solution of differential equations, differential equations of first order, orthogonal trajectories, linear differential equations of the second order with constant co-efficients, theory of operations, homogeneous equations of the second order, applications to problems of mechanics and physics.

### MECHANICS.

1. *Statics.* Elementary vector algebra, composition and resolution of forces, parallel forces, moments, couples, equilibrium of forces, friction, principles of virtual work with applications to frame-work, centre of gravity, stable and unstable equilibrium, strings.

2. *Dynamics.* Speed and velocity, acceleration, force, momentum and lawas of motion, work, power and energy, impulsive forces, impact of elastic bodies, projectiles, motion in a circle, small oscillations, motion in a resisting medium, tangential and normal accelerations, constrained motion on simple curves, moments of inertia, products of inertia, motion about a fixed axis, compound pendulum, applications to problems in engineering.

### FIRST YEAR COURSE FOR ARCHITECTURE AND REGIONAL PLANNING

1. *Calculus.* Differentiation, successive differentiation, intergration, maxima and minima, area, volume, arc length, Maclaurin's theorem.

2. *Trigonometry.* Logarithms, solution of triangles, heights and distances, DeMoivre's theorem, power series expansion of trigonometric functions, summation of series.

3. *Plane Co-ordinate Geometry.* Straight line, circle, definition and simple properties of ellipse, parabola and hyperbola.

4. *Solid Geometry.* Plane, straight line, sphere.

5. *Statics.* Forces acting on a rigid body, Moments of forces, Composition and resolution of forces, Conditions of equilibrium applied to simple framed structures.

6. *Dynamics.* Acceleration of a point moving in a circular path with uniform speed, simple harmonic motion, relative motion. Force, mass, impulse, momentum, work, power, energy. Moment of momentum, moment of inertia. Conservation of energy, conservation of momentum, rectilinear motion of a body under a force. Equation of motion of a particles.

### FIRST YEAR COURSE FOR GEOLOGY AND GEOPHYSICS STUDENTS

*Elementary Statics and Dynamics.*

1. *Statics.* Elementary vector algebra, composition and resolution of forces, parallel forces, moments, couples, equilibrium of forces, friction, centre of gravity.

2. *Dynamics.* Speed and velocity, acceleration, force, momentum and laws of motion, work, power and energy, impulsive forces, impact of elastic bodies, projectiles.

## 2. SECOND YEAR COURSES FOR CIVIL, ELECTRICAL, MECHANICAL, AGRICULTURAL, NAVAL AND GEOLOGY AND GEOPHYSICS.

*Analytical Geometry of three dimensions.* Equations of plane and straight line, Standard equations of conicoids, Equation of tangent planes.

*Advanced Calculus.* Rolle's Mean-value, Taylor's and Maclaurin's theorems, indeterminate forms, asymptotes, partial differentiation, total derivatives, directional derivatives, Taylor's series for functions of two variables, differentiation under the integral sign.

Series, Multiple Integrals, Line Integral.

*Differential Equations.*

(*i*) Simultaneous differential equations, linear equations with constant and variable co-efficients, Partial differential equations.

(*ii*) Formulation of Engineering problems, Application to transverse vibration of an elastic string, Heat flow, Vibration of a membrane, Laplace's Equation, Flow of electricity in a cable.

### SECOND YEAR CLASS FOR GEOLOGY AND GEOPHYSICS.

*Principles of Astronomy.* Great and small circles. Relations between the elements of a spherical triangle, celestial co-ordinates, equation of time.

## OPTIONAL SUBJECTS

**FIRST YEAR STUDENTS.**

*Elements of spherical Trigonometry.* Great circles and small circles on a sphere, poles, Pole of a graduated great circle, angle between two graduated great circles, elements of a spherical triangle, cosine and sine formulas, polar triangles. Right angled and quadrantal trinagles, Napier's rule of circular parts.

*Hydrostatics.* Pressure on plane and curved surfaces, centre of pressure, conditions of equilibrium of floating bodies, atmospheric pressure.

**SECOND YEAR STUDENTS.**

*Numerical Methods and Curve Fitting.* Interpolation, Numerical differentiation and integration, Numerical solution of ordinary differential equations, Theory of Probability and theory of errors, Principle of Least Squares, Curve fittings, Harmonic analysis. (Sixty percent of the course will be given in the Laboratory Classes).

THIRD YEAR STUDENTS.

*Higher Mathematics.*

1. Functions of a complex variable—Elementary function and their properties, Integration of complex functions, Cauchy's Residue theorem, Conformal mapping.

2. *Matrices.* Definition, Sum, Product and Transpose, Application to linear equations. Partitioned matrices in circuit problems.

3. *Operational Calculus.* Fourier-Mellin transform and their essential properties, Applications to ordinary and partial differential equation.

4. *Special Functions.* Gama, Beta, Legendre and Bessel's functions.

5. *Probability.* Elements of Probability, theory of errors, normal, binomial and Poisson distribution.

FOURTH YEAR STUDENTS.

1. *Statics.* Harder problems on elementary principles, Elements of three dimensional statics, *viz.*, Central axis, invariants, theoretical study of statistically indeterminate cases, Theoretical study of graphical methods, Machines.

2. *Dynamics.* D'Alembert's Principle, Two dimensional motion, impact with friction, Lagrange's equations and related topics, Rotating axes, Theory of vibrations.

3. *Hydrostatics.* Pressures on curved surfaces, Metacentre.

4. *Mechanics of continuous media.* Fundamental equations and solutions of some particular cases.

INTRODUCTION TO THE THEORY OF ELASTICITY.

Analysis of stress and strain in two and three dimensions. Problem in plane stress and strain using Airy's stress function. Pure bending, torsion and flexure of cylindrical rods.

INTRODUCTION TO HYDROMECHANICS.

General theory of perfect fluids, Bernoulli's equation, Theory of potential motion. Conformal transformation, Discontinuous motion. Flow and circulation theorems. Vortex motion. Gravity waves and related Hydraulic problems. Simple cases of motion in three dimensions. Poiseuille flow. Stoke's flow. Boundary Layer theory.

ADVANCED MATHEMATICS I.

Partial differential equations of Mathematical Physics, Vector calculus, Elements of tensors. Elementary statistical methods, Significance tests, Numerical analysis including method of least squares and curve-fitting.

ADVANCED MATHEMATICS II.

Introduction to the Dynamics of a system of particles and of rigid bodies, Elements of Mechanics of continuous media.

## COURSE OF STUDY IN WHICH STATISTICS SHOULD OCCUR AS OPTIONAL OR COMPULSORY SUBJECT.

(a) A. *Engineering Courses.*

(*i*) Under-graduate courses (3rd & 4th Yr. students) OPTIONAL

1. Civil Engineering
2. Electrical Engineering
3. Mechanical Engineering
4. Agricultural Engineering
5. Architecture and Regional Planning

(*ii*) Post-graduate courses
COMPULSORY

1. Industrial Engineering and Business Management
2. Production Technology
3. Elec. Communication Engineering
4. Chemical Engineering
5. Regional Planning.

B. *Applied Sciences Courses.*

(*i*) Under-graduate courses — Geology and Geophysics

(*ii*) Post-graduate courses

1. Non-linear Mechanics
2. Plasticity and Rheology
3. Geology and Geophysics
4. Applied Botany and Agricultural Sciences.

(b) *Regulations.*

(*i*) Under-graduate courses

This course should be *optional.* (In the Indian Institute of Technology the examination is taken in three parts, one in each term of the academic year. Each examination consists of a paper having maximum marks 100. Marks secured above 40 percent, is credited to the grand total.)

(*ii*) Post-graduate courses

The subject should be compulsory. (In the Indian Institute of Technology 200 Marks are provided for this subject in the Engineering Courses excepting Nonlinear Mechanics and Plasticity and Rheology.

SYLLABUS.

(*i*) Under-graduate courses in Engineering (3rd and 4th Yr. students)

*Statistics I.*

Addition and Multiplication theorems of Probability. Occupancy and ordering problems, Conditional probability, Binomial, Poission and Normal distributions. Law of large numbers. Frequency distribution: Moments and cumulants, Correlation, Regression and Prediction, Quality Control, Sampling Inspection scheme, Sampling distribution, Tests of Significance, Elements of sample surveys and preparation of statistical reports, Index-numbers (for Agricultural, Electrical, Civil, Mechanical Engineering and Geology and Geophysics).

*Statistics II.*

Estimation of parameter, Principle of maximum likelihood, Probit Analysis, Testing of hypothesis. Type I and Type II errors, Non parametric tests, Sequential tests, Information theory, Analysis of variance, Experimental Designs, Multivariate Analysis (for Agricultural, Electrical, Civil, Mechanical Engineering).

(*ii*) Post-graduate courses in Engineering.

(1) *Industrial Engineering and Business Management*—Descriptive Statistics Elementary Probability, Sampling Theory. Relationship correlation. Regression Analysis of Production Costs and Factory operation. Tests of Significance. Analysis of variance and covariance. Experimental Designs—Randomised Blocks. Latin and Greece-Latin squares. Incomplete Block Designs, Factorial Experiments, Confounding. Statistical Quality Control Methods—Control Charts for attributes and variables, Single, Double and Sequential sampling Inspection Plans. Index number and Time Series. Statistical Methods of studying Fatigues.

(2) *Production Technology*—Frequency Distribution, Measures of Central tendency. Dispersion, Skewness and Kurtosis, Tests of significance *t*, *F* and $X^2$ distribution Relationship of variables. Regression analysis, Sampling techniques—Planning an investigation. Routine control of Quality. Acceptance Sampling. Design of experiments—Randomised Blocks, Latin Squares, Balanced Incomplete Block Designs. Factorial experiments, Confounding, Youden Squares, Multivariate analysis Applications. Index numbers, Time Series.

(3) *Chemical Engineering*—Descriptive statistics, Probability and samples, Planning of simple comparative experiments. Statistical Inference. Sequential Tests of Significance, Experimental Designs—Analysis of counted data. Control charts. Sampling Inspection. Non-parametic tests. Randomized Blocks, Latin Squares, Greece-Latin Squares, Incomplete Block Designs, Factorial experiments, Youden Squares and confounding. The Determination of optimum condition. Response surface, Maximum Response—Scales of Measurement—Orthogonal composite Designs—Canonical analysis.

(4) *Communication Engineering*—Theory of Probability, Definition of a Stochastic Process. Principle classes. Orthoponal Random Variables. Markor Processes—Discrete and continuous parameters. Stationary Processes, Time Series analysis as applied to Communication Engineering—Periodogram and Multiple Harmonic analysis. Prediction and Lag with and without Noise. Statistical Techniques in the field of Traffic Engineering and Traffic Research.

(5) *Regional Planning*—Statistical measurements. Classification and tabulation of data. Types of

Distribution. Averages and dispersions. Graphical representation of Data. Sampling and standard Errors. Correlation, Curve fitting Interpolation. Index Number. Time Series. Vital Statistics. Causes. Population growth, Forecasts, Life tables. Official statistics. Sample surveys.

(l) NON-LINEAR MECHANICS & PLASTICITY AND RHEOLOGY.

(*iii*) Post-graduate courses in Applied Sciences.

1. *Numerical Methods.* (for students of Engineering) Finite differences, Interpolation, with one and two independent variables, Numerical differention and integration, Solution of equations, Theory of probability and errors, Method of least squares, Curve-fitting, Harmonic analysis, Numerical solution of ordinary and partial differential equations, Relaxation Methods.

Application to boundary value problems with special reference to non-linear mechanics and elasticity.

1a. *Numerical Mathematics* (for Mathematics Students).

Accuracy of approximate calculations, Finite difference, Interpolation formulae and their order of approximation, Numerical differentiation and integration, Algebraic and transcendental equations, Normal law of errors and precision of measurements, Harmonic analysis, Numerical solution of ordinary and partial differential equation, Solution of integral equation, Linear equation and Matrices, Characteristic numbers, Relaxation methods.

2. *Probability.* (For Engineering Students)

Addition and Multiplication theorem, Conditional Probability and Baye's Theorem, Binomial, Poisson and Normal distributions. Expectation, Law of large numbers, Holding and waiting times, Theory of Runs. Estimate of statistical mechanics.

2a. *Probability Theory.* (For Mathematics students)

Definition—Statistical probability, Combinatorial analysis, Occupancy and ordering problems, Conditional probability, Binomial, Bay's Theorem, Poisson and Normal distribution, Law of large numbers, Central Limit theorem with its application, Generating functions, Recurrent events, Runs and Renewal theory, Random walk problem, Markovchains, Stochastic processes.

3. *Statistical Methods*. (For Mathematics Students)

Frequency distribution, Moments and Cumulants, Correlation, Regression and Prediction, Tests of Independence, Small sample test, Analysis of variance, Experimental Designs, Estimation, Testing of hypothesis, Type I and Type II error, Quality Control methods, Sampling Inspection Plans, Probit analysis, Index-number, Time-series analysis, Sample-survey.

3a. *Statistical Methods*. (For Engineering Students)

Frequency distributions, Characteristic function, Sampling distribution, Tests of Significance. Theory of Estimation and testing of hypothesis, Regression theory, Analysis of various experimental design, Introduction to multivariable analysis, Index numbers and Time series, Quality control and sampling inspection plans.

4. *Statistical Mechanics*.

Classical Maxwell -Boltzmann statistics, Kinetic theory of gases, Fundamentals of quantum statistics, Theory of information. (Non-linear equations arising out of an-harmonic oscillators, Vanderpol equations, Stability of non-linear vibrations.)

(2) PHYSICS

Statistical Mechanics -Stochastic process and cosmic radiation Concept of probability in quantum mechanics.

(3) GEOLOGY AND GEOPHYSICS

General statistical methods, Tests of significance, Numerical analysis, Information theories, Autocorrelation analysis, Extrapolation, Interpolation and smoothing of time-series, Filtering problems.

(4) APPLIED BOTANY AND AGRICULTURAL SCIENCES.

Application of statistical methods to genetics, method for testing Mendelian hypothesis for individual character and for detection and estimation of linkage in simple cases, informations given by the various methods, combined estimation and testing heterogeneity, study of disturbed segregations, methods for the detection and estimation of linkage in human genetics.

(For drafting out the above syllabuses the following literatures were consulted.
Massachusetts Institute of Technology Bulletin—1954.
Imperial College of Science and Technology Courses of Study, 1954.
A Discussion on the Teaching of Mathematical Statistics at University Level, Journal of the Royal Statistical Society, Vol. 118, Part 2, 1955.)

In addition to these the committee has also been able to procure enough materials through correspondence and discussions with many distinguished workers in the field. It is proposed to prepare a draft syllabuses in Mathematics for various Under-graduate and Post-graduate Engineering courses for placing before the next joint metting at Agra for consideration and possible recommendation to the authorities concerned.

Many of the teachers have agreed to join the discussions and deliberations in the joint symposium to be held at Agra. The following advance notes have been received from some of them.

## 1. PRAN NATH (Banaras): *Teaching of Mathematics in Engineering Institutions*

If mathematics was considered as unavoidable subject, it is now considered an essential subject to build up the foundation of the engineering courses. As a matter of fact leading persons in the profession of engineering have realized that if a strong foundation can be built for the engineering students in the understanding of three fundamental subjects *viz.*, mathematics, physics and to some extend chemistry, then there would not arise difficulty in teaching the fundamentals of engineering and also giving the students glimpses of the most upon data developments in the field of engineering. This explains the present growing keeness for greater emphasis on the study of mathematics even in advanced forms for engineers. Since the attainment of independence India is faced with double responsibility in shaping the national policy in relation to constructional and industrial progress of the country. It has not only to make up the deficiency of the last several decades but has also to come abreast with countries which are highly developed industrially. As means to this end mathematics and its young offshoot statistics are going to play very important roles and happily too our engineers are realising this. If India is to produce the best on competitive level, the aid of statistics and in particular of the modern techniques of 'statistical quality control' will be found to be inevitable.

It is, therefore, time that we revise our courses in mathematics for engineering students and include in the curricula fundamentals of statistics for it is the statistical outlook imparted to an engineer which is going to play a much more important part in the industrial development of our country rather than securing the services of a few highly qualified statisticians in industry.

## 2. S. D. DUBEY (Kharagpur): *Mathematics Courses for Students of Engineering and Technology*

With the rapidly increasing application of statistical methods in almost all branches of engineering sciences, there exists an urgent need of imparting instructions on basic statistical theory with a bias of engineering applications to the present day students of engineering and technology all over the country. Unless the engineers of to-morrow, if not of to-day, are equipped with this ancillary tool, besides those already in existence, they can hardly afford to render first rate service to the nation in days to come. Instances are not rare of successfully tackling the most complex and intricate problems of engineering field with the aid of statistical principles. It would be no exaggeration to mention that some new statistical techniques have actually been developed while solving problems of various engineering and other fields. In the universities and technological institutions of the West, especially the United States of America, a short course of compulsory character in Engineering Statistics is being offered at both undergraduate and postgraduate levels of study since about a decade. This very fact dilates on the utility of the subject for both professional engineers and Engineer Scientists. It is thus high time for the curriculum builders and syllabus framers of a course in Mathematics for students of engineering and technology to include a short course of statistics in the revised syllabus of Mathematics. For, statistics being essentially a branch of applied mathematics can justifiably be integrated with it.

While framing the syllabus of statistics, proper care must be taken in respect to the selection of topics. Apart from the topics dealing with general statistical methodology, suitable selection of topics will be needed for different branches of engineering separately. Students of electrical communication engineering will profitably gain from the study of statistical time series analysis which is contributing a good deal in the day to day development of the subject. Statistical Quality Control methods and Operational Research techniques will prove indispensable for production engineers and so on. In fact statistical books on specific branches of engineering are gradually becoming available which will help considerably in this direction. Thus only proper training in statistics can enable engineers and technologists in developing broader outlook of statistical approach to their problems.

It is a pleasure to mention that the Indian Institute of Technology, Khargpur is already offering an optional course in statistics at undergraduate level and a compulsory one for postgraduate students of various engineering departments.

### 3. S. V. CHANDRASHEKHAR AIYA (Poona) : *Teaching of Mathematics for Engineering Research*

Engineers are required for (a) routine operation and maintenance of equipment, (b) installation of equipment, (c) the design and development of equipment and (*d*) modifications of designs to suit our special oconditions. Engineering in India is at present confined mainly to (a) and (b). Our material advancement depends principally on our concentration of effort to the type of work categorised under (c) and (*d*). Engineers categorised under (c) and (*d*) are often called engineer scientists. Engineer scientists must have a special training in mathematics and mathematical methods different from that required for the other classes.

What is science to-day is engineering tomorrow. This carrying over of the discoveries of science to engineering is the principal work of the engineer-scientist. It is the essence of engineering research and development work. This type of work calls for a capacity to understand and correctly assess the discoveries of pure science, for an intelligent exercise of common sense and discretion and above all, for a capacity to subject the work undertaken to correct quantitative evaluation within required and specified bounds. For the last enumerated objective, considerable knowledge of mathematical methods and ability to use them is necessary.

Apart from the routine mathematics that is at present taught in engineering colleges, it is necessary to be familiar with modern statistical methods and theory of approximations and its full significance. Numerical and graphical solutions of differential equations, Laplace, Fourier and other transforms, and use of Tables of Functions etc., must be taught as a routine to all engineer-scientists. Apart from this, some special training is required for the different branches of engineering. Thus, the electrical engineer must know spherical harmonics, Legendre polinomials, matrices and tensors, and so on.

It is out of question that the engineer scientist can be taught all the mathematics he is likely to require in his work within the four walls of a college. He has to read and learn the special branches of mathematics as and when he needs them. Mathematics must become something like an equipment or a tool in his workshop. For this to happen, the primary requisite is to create the atmosphere for frequent use of mathematical methods in solving day to day problems. Mathematics must be as frequently used in the lecture rooms, drawing halls and laboratories as a pencil or a screw driver. This is the essence of training in mathematics for the engineer scientist.

### 4. G. PICKETT (Calcutta). *Teaching of Mathematics in Engineering Institutions*

Attention is drawn to the fact that the teaching of mathematics to engineering students is frequently left to junior staff members of the mathematics department. It is argued that this is false economy. Attention is drawn to the wide gap between pure and applied mathematics and it is argued that teachers of mathematics to engineers should be either engineers or applied mathematicians rather than pure mathematicians. Examples are given to illustrate the damage that results when an engineer receives his instruction in mathematics from one who is primarily trained as a pure mathematician.

### 5. G. BANDYOPADHYAY (Kharagpur) : *Setting of Questions*

A change in the modes of setting questions has been suggested. The essential point in the new suggestions is that the paper is to be devided into a few parts each part testing different qualities *e.g.*, knowledge of standard topics, capacity of independent thinking etc.

## 1. Statistical Methods in Engineering & Metallurgy.

## SECTION OF STATISTICS

It was a joint discussion with the Sections of Physics and Engineering & Metallurgy. The discussion was opened by Prof. N. Weiner (U.S.A.) who referred to some important problems in engineering and physics where statistical methods were finding increasing applications; *e.g.*, the problem of finding the best approximation to message affected by noise, vibration problem, problems of geology etc.

### 1. DR. I. R. RAO (Madras)

Discussed the coal resources of India with reference to fuel energy requirement.

### 2. DR. K. C. CHAKKO (Aligarh)

Referred to some problems of transportation which needed statistical investigation.

### 3. DR. S. V. CHANDRASEKHAR AIYA (Poona)

Statistical methods are required for the analysis of data used in engineering designs. They are also required to deduce relations on the behaviour of installations, loading of equipment etc.

### 4. DR. M. K. GANGULY (New Delhi)

Statistical methodology and its applications to engineering problems are becoming more and more popular these days. But still it appears that the technical resources of the subject have not been exploited to the full extent

The above remarks have been amplified with some concrete problems in engineering which the speaker came across during the past few years. The solution of the most of the engineering problems involve too many unknowns to enable an exact treatment being followed. As a result Statistics steps in there as a science of approximation to render a sufficiently reliable guidance. Statistical methods were in use in engineering problems in some form or other from very old days but with the development of the recent techniques and more accurate observations being made available the subject has assumed a great importance now-a-days. With well chosen examples in the engineering field, the usefulness and applications of the sampling technique, the design of experiments, time series analysis etc., have been amply demonstrated. In this connection the placing of syphons before the *Hirebhasgar dam*, evaluation of the popularity of a river valley project and calculation of 'desire lines' in the origin destination surveys were explained. And summing up the speaker remarked that in the days to come Statistics will find many more applications in the solution of engineering problems where its power remains still unexplored.

### 5. DR. A. K. GAYEN (Khargpur)

Development in various branches of Engineering such as mechanical, civil, electrical, etc., and particularly those that have come into prominence in the second quarter of this century such as chemical, agricultural, and nuclear engineering etc., has been with the increasing application of basic physical sciences like Mathematics, Physics, Chemistry and Statistics. Mathematics and Mechanics remain as ever to be essential pre-requisites for students of Engineering Sciences. But time has come now when want of teachers in Statistical theory and practice in any technological institute will be considered as much an anomaly as the absence of teaching arrangements for mathematics and mechanics. Rapid developments are taking place in mathematical statistics and its applications in quantitative experiments of general sciences and engineering. Theory of probability and Statistics is being applied in routine control and factory operations. Sooner or later in his career a Scientist or Research Engineer is almost certain to feel the need of use of statistical methods and it is good that he should adopt the right approach from the start than wait until later years. Earlier introduction of statistics in the curriculum of studies in colleges of Science and Engineering would as such prove to be highly beneficial. The recent symposium on teaching of mathematics and Statistics in Engineering College under auspices of Indian Science Congress 1955-56 had laid special stress on the syllabuses for Mathematics and Statistics in branches of engineering and recommended a revision of existing syllabuses in mathematics and an introduction of suitable statistical courses. There should however, be well thought-over curriculla for students in Technology and General Sciences and there should be an option for statistical courses. For it should be recognised that not many of the students will become practising statistician and the aim should therefore be to teach students to recognise a statistical problem in the given field of application, to know what kind of solution is possible and to understand and interpret the statistical inferences.

## I. National Sample Survey

In introducing the topic for discussion, the President, Dr. Nagabhushanam, requested the speakers to limit their remarks to technical and scientific aspects of the subject and to base them, as far as possible, on published literature. The discussion was opened by Dr. N. S. R. Sastry.

### 1. Dr. N. S. R. Sastry (Bombay)

Though I did not intend to participate in the symposium, I obey the call of the Chair and present before you a few of my personal observations on this question. The Chairman has already indicated that the discussion should be confined to the scientific aspects of the subjects based on published literature of the National Sample Survey. In the first instance, it should be recognised that this project had been approved by the Union Government and has been continuing for nearly five years and at this time, it will be desirable to give only constructive suggestions regarding the best possible use that can be made of the survey rather than pick holes and denounce it.

Let us first examine how far the objectives of the survey have been fulfilled. It may be noted that the objectives of the scheme are fairly wide and embrace collection of dependable data on different socio-economic aspects of the country. In the first phase it was intended to obtain fairly dependable data regarding the broad aspect of National Income in respect of the Union of India from different types of enterprises, and also to provide a continuous flow of information of use to the Central Government for its day-to-day administration and policy making and for planning purposes. was stated in the final report of the National Income Committee that the data collected by N.S.S. could not be used for National Income Estimates for 1950-51; however, it would appear that the data were used for the estimates of the subsequent years. The N.S.S. supplied some data to the Taxation Enquiry Committee and Press Commission also. It is not known how far the data supplied by the N.S.S. have been made use of for the policy decisions of the Government and for planning purposes but some useful data seem to have been collected on refugees rehabilitation and unemployment situation. Thus, though the objectives have not been completely fulfilled, an important beginning seems to have been made. Further, the scope is being extended with the co-operation of State Governments.

The main criticism against the N.S.S. is the long time-lag which limits the usefulness of the data for policy purposes and also about the validity of some of the estimates in the published reports. In this connection, it may be noted that such criticism on estimates are made on the results of similar surveys conducted in foreign countries also and on detailed examination, it was found that a good deal of the difference was due to want of uniformity in definitions etc. However, this question of validity of estimates needs further detailed examination. As regards the time-lag, part of it is due to organisational difficulties and a part to taking up considerable amount of priority work. With centralised administration and advice and a good deal of decentralisation in work by assigning to concerned ministries and States, it may be possible to lessen the time-lag considerably. Incidentally, it may be pointed out that some schemes for such decentralisation have already been progressing. It may be useful to confine the activities of N.S.S. to such projects which overlap the functions of two or more ministries and certain important and strategic items of work. In this connection, the organisation of opinion surveys on the lines of IFO Business Activity Surveys of Germany, for immediate policy decisions, may be considered.

## 2. DR. K. KISHEN (Lucknow)

The N.S.S. (National Sample Survey) was started in 1950 with a view to obtaining comprehensive and reliable statistics relating to all economic and social aspects on an all-India basis, particularly for those sectors for which reliable statistics were not available. The First Round of the survey, which covered only the rural areas, was operated from October 1950 to March 1951 for collecting information for the period July 1949 to June 1950. The Second Round, which again covered the rural areas, was operated from April to July, 1951. The Third Round was carried out from August to November, 1951 and covered, besided rural areas, the four big cities of Calcutta, Bombay, Madras and Delhi and 50 towns scattered over the whole country. Subsequently, the further rounds of the survey till the Ninth Round have been completed and the Tenth Round of the Survey is now in operation since December, 1955. The NSS is one of the largest sample surveys ever undertaken in any country of the world. It is also most comprehensive in scope and information on a very large number of socio-economic items is being collected through it. Owing to the omnibus character of the survey and the subjective method of interview in collecting information that has been adopted, there have been growing misgivings among statisticians in this country about the reliability of the primary data collected under this survey and the efficiency of the estimates obtained on the basis of these data. It is also felt that there is considerable room for improvement in regard to the reliability of these primary data by the adoption of objective measurement techniques by the Field Investigators.

What strikes one in going through the reports so far published on the various rounds of the survey is the absence of any standard errors of the estimates given in these reports. This renders the task of assessing the efficiency of the NSS estimates very difficult. It has been stated in the report on the first round that these standard errors are under calculation. However, although some years have elapsed since the report on the First Round was published, these standard errors have not been published so far. It is, therefore, felt that the NSS should take very early steps to publish the standard errors of the estimates given out by them to enable their precision to be judged.

In the report on the first round, two grossly divergent estimates of food production have been given, one on the basis of the information regarding the quantity of production of foodgrains and the other on the basis of consumption of foodgrains from home-grown production by sample households. The estimate of food production based on information about the quantity of foodgrains has been dismissed in the report as a gross under-estimate. However, the estimate of 60.16 million tons based on consumption from home-grown production has been taken as accurate on the ground that (*a*) there is satisfactory agreement between the estimated consumption of salt with the estimated supply available for consumption, and (*b*) there is a close agreement between the total estimated consumption of foodgrains in West Bengal with their estimated total supply. In both (*a*) and (*b*), however, the net production available for consumption has unfortunately been confused with the gross production both for salt and foodgrains. When this mistake is rectified, the close agreement pointed out between the estimates of production and supply no longer exists. Thus, for instance, the net production of foodgrains available for consumption in West Bengal during the year July 1949–June 1950 was 4.03 million tons. Making allowance for normal losses, seed requirements, etc., at the conventional rate of 12.5% the gross production of foodgrains based on consumption comes out to be 4.53 million tons as against an estimated supply of 4.09 million tons. Thus, the gross production based on consumption for 1949-50 exceeds the estimated supply by 0.44 million tons, or by 11%. For the whole of India, the net production based on consumption of foodgrains has been estimated at 60.16 million tons, so that the gross production would come out to be 68 million tons in round numbers. Against this, the official estimate of production based on random crop-cutting surveys, with extrapolation for tracts not covered till then by these surveys, was 49 million tons. This would seem to show that the NSS estimate of food production based on consumption in a gross over-estimate.

The reasons for such widely divergent estimates for an important item like food production are not far to seek. The NSS is an interview or opinion survey and the estimates obtained on the basis of the data collected under the survey are subject not only to sampling errors but to large non-sampling errors in consequence of the intrinsic biases of the enumerators. The mathematical formulae for the biases in the estimates and the increase in the sampling variance by the variability in these biases will now be briefly discussed. Let $y_{ij}$ denote the value reported by the $j$-th enumerator on the $i$-th unit and let $x_i$ denote the true value of the character for the $i$-th unit in a sample random sample of $h$ units. Then

$$y_{ij} = x_i + \alpha_j + \varepsilon_{ij}.$$

where $\alpha_j$ represents the bias of the $j$-th enumerator in repeated observations and $\varepsilon_{ij}$ represents the deviation of $x_i + \alpha_j$ from the reported value. We shall assume that $\varepsilon_{ij}$ is randomly distributed around zero with variance $s_e^2$ for all $i$ and $j$ an assumption which is usually realized in practice.

Denoting the sample mean by $\bar{y}$, it is easily seen that

$$E(\bar{y}) = \mu + \bar{\alpha} \qquad .. \quad (1)$$

where $\mu$ is the population mean of the true values, to be estimated, and $\bar{\alpha}$ is the population mean of the enumerators' biases. Also, it can be shown that the variance of the sample mean is given by

$$V\,(y) = \frac{Sy^2}{h} + S_\alpha^2\left(\frac{1}{n} - \frac{1}{m}\right) \qquad .. \quad (2)$$

where $S_y^2$ represents the variance of a single observation and $S_\alpha^2$ is the variance for the enumerators' biases. It would appear from the formula (1) above that unless the individual biases of the enumerators vary in such a way as to cancel out, the sample mean will not provide a reliable estimate of the character under study. Besides, even if the enumerators' biases are such as would cancel out, the contribution of the second component in formula (2) for sampling variance of the mean might be very large unless every effort is made by adoption of objective measurement techniques to control the variability of the biases among the enumerators.

This emphasizes the need for the immediate adoption by the NSS of sound measurement techniques, based where possible on the method of physical observations, in order to make the sample estimates free from bias and ensure that the observational errors are under control. Now that the NSS has collected a very large volume of data by the interview or opinion method, which would be adequate for supplying information, although unreliable, for sectors for which such information is badly needed for purposes of planning, it is high time that the efforts of the NSS are directed in future rounds to the collection of sound statistical data, particularly for such sectors for which this information is lacking, by following objective and statistically sound measurement techniques, based as far as possible on actual physical observations. This may necessitate simplification of the NSS schedules and placing a whole-time Field Investigator in one or more sample villages for purposes of keeping records of households randomly selected in these villages throughout the period of investigation. This approach, it may be mentioned, has already been adopted with success in sample surveys carried out for collecting scientific data on cost of production and consumption. It is only by modifying the design and scope of the NSS in the manner suggested above that reliable statistical data for purposes of planning can possibly be collected.

### 3. DR. M. N. GHOSH (Calcutta)

The national sample survey was organised to fill up certain lacunae in economic statistics regarding the population of India. The importance of this particular survey over any other survey conducted before lies in the fact that its findings will be used as a guide to economic planning. The first round of the survey (July 1949–June 1950) has been completed and a report is available but though the survey has gone through about nine more rounds full reports for these have not been published, though tables for some of these are available. Even for the first round of the survey standard errors have not been published so that the published report is still incomplete from a statisstician's point of view. The report of the NSS (first round, page 39) states that calculation of standard errors had been stated at the time the report was written (1952) but nothing has been published since then. For the fourth round of the survey, however, standard errors for the expenditures of families are available (submitted to the Taxation Enquiry Committee and published in their report) and these have been considered here.

There may be different methods for the appraisal of the results of a survey. The first criterion is that it should not be in violent diagreement with our prior knowledge.

which is based on the common experience of the people—the admissibility of this criterion has been mentioned in the report of the NSS (first round) itself. Often a survey can add to our store of knowledge by supplying quantitative estimates of variables, but it seldom happens that a survey does refute the basic understanding of social facts. The second criterion is the internal consistency of the results of a survey and observations which are not naturally consistent indicate something wrong somewhere. The third criterion is conformity with the results of similar other studies. In the absence of any other survey with an All India Scope, the third criterion does not help us.

In the report of thefirst round of the NSS consumption of salt in different zones was compared with the trade figures for availability of salt and it was remarked that the mean consumption of salt in different zones has a characteristic variation. Naturally for a stable article of consumption as salt, we do not expect much variation in time. However, the results of the different rounds of NSS does not confirm this expectation.

INDICES OF THE VALUE OF CONSUMPTION OF SALT (N.S.S.) IN RESPECT OF DIFFERENT ZONES.

| | N. India | E. India | S. India | W. India | C. India | N.W. India | All India |
|---|---|---|---|---|---|---|---|
| 1st Round | 86 | 109 | 109 | 74 | 108 | 94 | 100 |
| 2nd Round | 100 | 100 | 92 | 85 | 100 | 92 | 100 |
| 3rd Round | 100 | 100 | 92 | 77 | 100 | 77 | 100 |

We shall naturally expect the same pattern for the quantity indices since prices of salt in different regions are unlikely to have changed much during this period.

The pattern of consumption of milk and milk product also reveals a great deal of variation during different rounds of the survey in different zones.

INDICES OF THE VALUE OF CONSUMPTION OF MILK AND MILK PRODUCTS IN RESPECT OF ALL INDIA CONSUMPTION.

| | N. India | E. India | S. India | W. India | C. India | N.W.India | All India |
|---|---|---|---|---|---|---|---|
| 1st Round | 108.7 | 42.1 | 50.9 | 151.7 | 79.8 | 354.3 | 100 |
| 2nd Round | 106 | 52 | 45 | 165 | 71 | 362 | 100 |
| 3rd Round | 121 | 59 | 38 | 160 | 82 | 284 | 100 |

It will be observed that the relative orders of the consumption indices for East India and South India have been completely reversed during these surveys and the third round indices for these regions conforms more to our basic knowledge of the diet of Eastern and Southern India. The same kind of situation has been observed for sugar also, which is also a staple commodity.

The unreliability of the income and crop yields have been admitted in the report of the first round (N.S.S.), and a calculation of total family income shows a deficiency of 25% from family expenditure in the different zones, which cannot be explained by the sampling error. Thus it would imply either the income or the expenditure figures or both are wrong, unless we assume that the expenditure of the rural population is either subsidized by the Government or is bolstered by credits from the urban population to make up the deficiency.

It is interesting to consider the standard errors for expenditure which are availabe for the fourth round of the survey.

N. S. S. FOURTH ROUND

PER CAPITA CONSUMER EXPENDITURE IN RURAL AREAS ONLY FOR A PERIOD OF 30 DAYS AND THE ESTIMATED STANDARD ERRORS.

(From Taxation Enquiry Commission Report)

| State | Number of Sample Units | | Per Capita expenditure | Standard error (in Rs.) | Standard error (per cent) |
|---|---|---|---|---|---|
| | Villages | Households | | | |
| Assam | 24 | 218 | 24.12 | ±2.39 | 9.92 |
| Bihar | 120 | 1078 | 23.73 | ±2.08 | 8.74 |
| Bombay | 104 | 1039 | 18.85 | ±0.41 | 2.18 |
| Madhya Pradesh | 60 | 562 | 16.23 | ±0.80 | 4.94 |
| Madras | 94 | 980 | 18.21 | ±0.02 | 0.11 |
| Orissa | 32 | 341 | 14.86 | ±1.59 | 10.73 |
| Punjab | 36 | 309 | 30.72 | ±0.69 | 2.25 |
| U.P. | 148 | 1407 | 23.04 | ±0.43 | 1.87 |
| West Bengal | 72 | 533 | 27.09 | ±0.27 | 1.00 |
| Hyderabad | 56 | 470 | 15.10 | ±0.38 | 2.50 |
| Madhya Bharat | 20 | 149 | 19.79 | ±3.02 | 15.25 |
| Mysore | 25 | 215 | 19.76 | ±0.47 | 2.40 |
| Pepsu | 12 | 82 | 35.14 | ±7.26 | 20.67 |
| Rajasthan | 60 | 502 | 22.52 | ±1.59 | 7.05 |
| Saurastra | 20 | 136 | 19.95 | ±1.62 | 8.11 |
| Travancore-Cochin | 30 | 262 | 18.48 | ±0.83 | 4.50 |

The above table gives the per capita expenditure in the rural areas of Bombay to be much smaller than those of Bihar, which is against our common knowledge and also against the result of the N.S.S. first round survey. However, even admitting that the average expenditures in different areas may depend upon the season in which the survey was conducted, we naturally would expect the variations (*i.e.*, standard diviations) to be of the same order. The estimates of standard deviations of the expenditures in Bihar and Madras are

$$2.08 \times \quad 1078 = 68.7 \text{ and } 0.02 \times \quad 980 = 0.63$$

respectively *i.e.*, one is more than hundred times the other even though the sample size was quite large, so that this can not be explained by sampling functions only.

We have seen above that the results of the N.S.S. neither possess internal consistency nor do they square with the known facts of India's economic life. It is difficult to guess the relative importance of different causes of such errors. The most important presumably is the size of the schedule which runs to 14 pages but fundamentally these errors are inherent in this kind of surveys by interview method. The official crop estimates have been criticised as underestimates in the report of the N.S.S. (first round). While we hold that there is scope for improvement in the collection of agricultural statistics, the actual degree of error in these may not be as large as the N.S.S. report would suggest. In fact Mr. A. R. Sinha, a past president of the statistics section of the Indian Science Congress, has shown that the official yield figures for cotton are in very good agreement with trade figures for mill consumption, taking account of export and important of raw cotton C.S.A. Bulletin, No. 6).

It would certainly be reassuring to find that the results of the successive rounds of the N.S.S. are improving in quality but unfortunately indications to this direction have only been meagre so far.

## 4. SRI J. K. PANDE (Lucknow)

He said, he spoke as a critic of the National Sample Survey, but a critic not from outside but from inside, being in a sense a part of the National Sample Survey. He drew attention to the President's announcement that the symposium was restricted to the technical statistical aspect of the NSS. No one, however, had suggested that there was any statistical defect or drawback or weakness in the technique of planning the inquiries under the NSS or of analysis of data collected. He ,and he thought the NSS authorities also, would welcome any constructive suggestions for improvement in the statistical technique followed in NSS. No one claimed perfection and there was always scope for improvement, and that being so, there would be readiness to appreciate and welcome constructive criticism.

Referring to certain figures given by previous speakers in criticism of the NSS, Sri Pande emphasised the need of maintaining a scientific attitude in criticising or denouncing figures. Great care was necessary in securing full information regarding limitations and scope of the figures which were criticised. As an illustration, he referred to figures of consumption expenditure for Bombay and Bihar and to the emphatic statement of a previous speaker that he was not prepared to believe that those figures could be correct. Sri Pande thought that perhaps the previous speaker had overlooked the fact that those figures of consumption expenditure related only to rural areas of the two States and to only specific period of the year; if these important factors were kept in mind, he was not prepared to assert that the figures in question were necessarily wrong. While pre-existing notions and hypotheses were useful in their own way, it would be unscientific and dangerous to regard any conclusions which were thrown up by correct statistical enquiries but which were in conflict with those notions and hypotheses, as incorrect and unbelieveable. No doubt greater care was needed to examine the circumstances and the technique of the inquiry which threw up such results, but outright rejection of such figures would defeat the very purpose of research.

Sri Pande strongly emphasised the need of reliable primary data. He cautioned against over-emphasis on employing fine statistical techniques in planning inquiries and analysing data to the detriment of primary data. While such statistical techniques were obviously useful and should be employed, equal care was necessary to see that the primary data did not suffer from too large a margin of unreliability. In this connection, it was necessary to draw upthe questionnaire carefully so that the investigator was not required to ask impossible questions or to seek information which could not be given with a fair degree of accuracy. Likewise, the work load on the investigator had to be carefully assessed in order that its usefulness may not unfavourably react on the reliability of data collected by him. All these were important points which had been considered and were being continually given further attention in NSS; and if the symposium could bring up any suggestions for improvement in this direction, its purpose will be very well served.

## 5. SRI M. D. BHAT (Bombay)

**There are just one or two observations which I would like to make. Regarding the consumption per rural family obtained in 4th round of the National Sample Survey and supplied to the Taxation Enquiry Commission, it is likely that a part at least of**

the apparent discrepancies in the values obtained for the three States, Bihar, Madras and Bombay, may be attributed to a slightly different method of sampling adopted in that round of the Survey, namely, that of selecting tehsil as the first stage unit in the multi-stage sampling design. The direct sampling of villages from the strata would have been more efficient.

Secondly, it may be worthwhile to compare the results of the National Sample Survey with those of the Rural Credit Survey conducted by the Reserve Bank of India. In respect of a few of the common items of expenditure appearing in these Surveys, agreement was almost prefect in respect of expenditure on (*a*) clothing, shoes, bedding, etc., (*b*) household furniture and other equipments, (*c*) ceremonies, (*d*) educational and medical expenses. In the case of improvement of land, repair of houses, wells, etc., the results obtained by the Rural Credit Survey was more than 3 times the value obtained by the National Sample Survey.

The slight difference in the periods covered by the enquiries cannot normally lead to such a large difference in the averages. We do not have the full information necessary to examine whether there is likely to be any difference due to definitional differences. However, from available information, it would appear that definitional differences might not be a major factor. While the Rural Crecit Survey data are based on 1,30,000 families from 600 villages (for the General Schedules, all families in each of 600 villages were covered), the National Sample Survey data relate to a much smaller number of families, but spread over a larger number of villages. This, it would appear, is an important contributing factor as regards the difference between the averages obtained in the two Surveys. The data relating to land improvements and other capital formation as also land utilization and production must be collected from a larger sample to be able to get more reliable estimates.

## 6. Dr. Des Raj (Calcutta)

The error of an estimate obtained from a sample survey (such as the NSS) is made up of sampling and non-sampling errors. Sampling errors are reduced by choosing an efficient design (involving stratification, pps sampling etc.) and the non-sampling errors are controlled by training the investigators in the methods of measurement, supervision of field work and reduction of the rate of non-response. The technique of interpenetrating sub-samples permits estimation of both types of errors. With regard to the magnitude of non-sampling errors associated with the interview method of enquiry a special investigation on this point was carried out. Information on consumption of cereals was collected by the interview method and the method of physical measurements. It was found that the interview method compares very favourably with the so-called objective method consisting of physical measurements.

With regard to the use of supplementary information in the form of village populations based on the 1951 census, it has been found that sampling with probabilities proportionate to these sizes is very efficient as compared to sampling with equal probabilities.

Regarding the suggestion of decentralisation, this will raise several difficulties and costs will mount. To take one example, if a single agency conducts both the household enquiry and the land utilisation survey, these enquiries can be suitably integrated; if two different agencies undertake these enquiries costs will be higher and the advantage of integration is lost.

The NSS is a scientific enquiry. Its findings are not a matter of opinion. Those who feel that it has not met with cent percent success, lose sight of the nature of a scientific enquiry in that it is a campaign and not a conquest.

Besides the above speakers, Messrs. D. B. Lahiri, N. C. Ghosh, M. A. Telang and others took part in the discussion.

# "Geological Age Determination with the Aid of Radio-activity"

## SECTION OF PHYSICS

1. R. S. **Krishnan** (Bangalore): *Measurement of Geologic time in the Precambrian Era*

A brief review of the various methods applicable especially to the Precambrian is given under the following headings.

(a) The lead methods
(b) The alpha-helium method
(c) The Rb-Sr method
(d) The argon-potassium method.

The assumptions underlying the various methods, their difficulties and sources of error are indicated. A brief account is given of the alpha-helium method. The helium ratios determined for a number of Precambrian specimens in the laboratories of the Physics Department, Indian Institute of Science, are presented. The general nature of the results is indicated.

2. V. S. **Venkatasubramanian** (Bangalore): *Helium Ratios in Rocks & Minerals and the Helium Leakage Problem*

A very brief review of the considerable body of data obtained by various workers on helium ratios is given, along with some additional data obtained in our laboratories. The various sources of helium leakage are discussed. A modification of the theory involving diffusion by the ' hole ' mechanism is given along with the necessary modification of the equations for age determination. The results are discussed in the light of the experimental data, and the effect of grain size on diffusion is also discussed.

3. V. S. **Aithal** (Bangalore): *Alpha-activities of Rocks and Minerals*

The methods of determination of the $\alpha$-activities of rocks and minerals, in particular, the scintillation counter method, are discussed. The apparatus and procedure, as employed in our laboratories are discussed. The sources of error, and the necessary precautions are also given. Values for a number of Precambrian specimens are presented, and the general nature of the results is discussed.

4. P. S. **Goel**, S. **Jha**, D. **Lal**, B. **Peters**, P. **Radhakrishna** and Rama **Thor** (Bombay): *On the Occurrence of Cosmic Ray Produced $Be^7$ and $Be^{10}$ Nuclides and their Possible Application in Meteorology and Geological Dating*

The production of the two nuclides of beryllium, $Be^7$ and $Be^{10}$, by cosmic rays is discussed. These nuclei are carried down from the stratosphere and reach the earth's surface as constituents of rain water.

The shorter lived isotope, $Be^7$ (half life 53 days), is suitable for the study of the movement and circulation of air masses and, therefore, of interest primarily to meteorology.

The longer lived isotope, $Be^{10}$ (half life $2.7 \times 10^6$ years), might permit age determinations of geological surface changes in the Tertiary, where the present methods based on $C^{14}$ and natural radioactivity are not applicable. It is hoped to use the $Be^{10}$ isotope to measure the sedimentation rates on the floor of oceans.

## 5. P. RADHAKRISHNA and P. S. GOEL (Bombay) : *Chemical Problems Associated with the isolation of Beryllium Produced by Cosmic Radiation*

The carrier free separation of the beryllium produced by cosmic radiation has two aspects :

1) the isolation of the short lived $Be^7$ from rain water and snow

2) the isolation of the long lived $Be^{10}$ isotope from ocean sediments.

An ion exchange process followed by purification using thenoyl trifluoroacetone (TTA) was employed in the first case.

In the second case, after attack by alkali fusion the beryllium was separated from the ocean sediments using TTA and finally purified by successive cycles using acetylacetone and cupferron.

## 6. S. L. MALURKAR (Bombay) : *Radio-active Isotopes for study of Tropical Meteorology and Tropical Oceanography*

The ultimate origin of air streams or ocean currents in the equatorial regions is of great theoretical and practical value. Ordinarily the equator acts as a barrier for transport of fluids across it. Under certain conditions the transport is possible, *e.g.*, in the monsoons, or for feeding into cyclonic storms and considerable doubts still exist about the role of various streams unlike those in higher latitudes which belong to only one hemisphere. The climatic conditions in the Indian, Pacific and Atlantic Oceans near the equator are different. The high pressure area extends over S. Atlantic Ocean throughout. The belt of low pressure in the Pacific is narrower than in the Indian Ocean where the low pressure area moves over a wide latitudinal belt during the course of the year. The details and intensity of any phenomena would not be identical. It would be worth knowing whether the air is actually transported from the equator to the head of the Bay of Bengal and whether the S. E. Trades or the air from the roaring forties have anything to do with the Indian Monsoon.

By distributing isotopic material at predetermined places and by looking for them at expected regions later, if needed in successive seasons, valuable data may be got. The regions of dispersal for Indian area would have to be : Long. 100° to 120° E., Lat. 5° to 15° S., Long. 90° to 100°E., Lat. 30° to 40°S.; and equatorial region of Africa (East) to be detected after 7 to 20 days, in the China Seas to be detected after 3 to 7 days; near the equator at the time of crossing a monsoon 'pulse' to be detected after 3 to 4 days. The corresponding positions in Winter can be put down by symmetry. The choice of isotopic material would be determined from the above periods and facilities available. In the sea also similar regions can be easily stated. The investigation would have to be three dimensional.

As such investigations have already begun in India according to Peters, it is hoped that valuable data would be collected with suitable collaboration of Meteorologists and Oceanographers.

## II Modern Radiation and Particle Detectors

### 1. B. V. THOSAR (Bombay): *Luminescence of Crystals excited by Electrons*

While extensive data on photo-luminescence of crystals are available, the subject of crystal luminescence excited by nuclear particles and radiation is of comparatively recent origin and has become important due to the increasing use of scintillation counters in nuclear physics work. A survey is given of the current ideas on the mechanism of excitation of luminescence in crystals by electrons and an attempt is made to reach a precise definition of 'luminescence efficiency' for electron excitation. This is necessary as crystal luminescence is ultimately due to electrons, whatever the primary ionizing radiation, alpha-, beta-, or gamma-rays.

Some experiments on variation of mean pulse height due to luminescence response of some scintillator materials to low energy electrons are described.

### 2. ANIL CHANDRA CHATTERJEE and SANTIMAY CHATTERJEE (Calcutta): *Study of the behaviour of different phosphors and photomultipliers for use as a scintillation $\gamma$-ray spectrometer*

Recently a scintillation $\gamma$-ray spectrometer has been set up at this Institute for studying the behaviour of different phosphors of various sizes using different photomultipliers such as 1P28, 5819, 6262, 5659 etc. A collimated source of $Co^{60}$ was used as the standard. This main purpose of setting this spectrometer was to study the nature of the phosphors that are being grown up by us at this Institute. Aluminium Oxide is used as the reflector of light for the phosphor.

The output positive pulses from one of the later stages of the dynodes were fed to a preamplifier having a band width of 5 Mc/s and a linearity of up to 5 volts output and a gain of 6.

The main amplifier was a variable gain linear amplifier with a linearity of upto 80 volts output. Its band width also was of the order of 5 Mc/s. The overload characteristics of the main amplifier has been studied thoroughly and found satisfactory. A Model 510 Pulse Height Analyzer of the Atomics which can handle pulses up to 100 volts, has been used for pulse height analysis.

Using different phosphors of various sizes with different photomultipliers it is found that for spectrometric purposes the RCA 5819 tube and NaI (Tl) crystal are the best suited.

### 3. G. S. GOKHALE and V. K. BALASUBRAHMANYAM (Bombay): *Cerenkov Counters as Particle Detectors*

The use of Cerenkov effect in determination of energy and charge of high energy particles in Cosmic Radiation and Nuclear Physics are discussed. The advantages of the Cerenkov counter over other detectors such as proportiona lcounters, ionisation chambers, scintillators etc., in the study of the charge spectrum of primary Cosmic Radiation are dealt with. Experiments on the

1) directional
2) velocity, and
3) charge dependence of the Cerenkov effect are described and preliminary results obtained with a Cerenkov counter in this laboratory are reported.

### 4. Shree Raman and S. K. Bhattacharjee (Bombay): *Studies on the Radiations of some Radioactive Isotopes by coincidence Scintillation Spectrometer*

A Coincidence Scintillation Spectrometer, using the "Fast-Slow Coincidence" method has been constructed at the Institute. It consists of two scintillation spectrometers each equipped with amplifiers and single channel analysers for appropriate energy-selection in each channel. The fast photomultiplier pulses are also fed to two fast amplifiers (~8 MC band width) whose outputs are fed to a coincidence circuit of resolving time $2 \times 10^{-7}$ sec. The two single channel as well as this coincident outputs are fed to a slow triple coincidence circuit. This method of fast-slow coincidences eliminates any timing error since all pulse-height selection follows the timing circuit.

The various applications to which such an instrument is put in the field of Nuclear Spectroscopy are:

a) Internal conversion measurements;
b) Positron-K-capture ratio;
c) Cascade sequence of $\gamma$-rays;
d) $\beta$-$\gamma$ coincidences; the efficiency of this instrument for bringing out weak partial $\beta$-groups;
e) Delayed coincidences to measure life-times of excited states;
f) Angular correlation experiments.

Some measurements made on the radiations of $Tm^{170}$, $Eu^{154}$, $Na^{22}$, $Sb^{125}$ are to be presented.

### 5. B. Basu and B. D. Nag (Calcutta): *Design of Scintillation pair-spectrometer and some preliminary studies with it*

The Scintillation counter has proved to be a very fruitful device for investigating nuclear radiations. The linear behaviour of phosphors like NaI (Tl) with gamma-ray energies has made possible the energy determination of high energy gamma-rays. However for a gamma-ray of particular energy, usually three peaks are obtained with a single crystal spectrometer, corresponding to photo-electric effect, Compton effect and pair production. If the nuclei under investigation emits more than one gamma rays the interpretation of the observed spectra becomes quite difficult. This has been obviated by using a three crystal spectrometer which will preferentially select only the pair production process and as such will give only one peak for each gamma-ray. This system has the further advantage of eliminating background radiations which may be present and causes a good deal of trouble with a single crystal spectrometer. The pair spectrometer is described. It uses a Dumont 6292 for the central spectrometer channel and RCA 5819's for the side channels. The system is quite versatile and with a minimum number of changes can be used to record Compton peaks, using anthracene or stilbene crystals. Some preliminary results with the apparatus will be described.

### 6. S. Jha and R. K. Gupta (Bombay): *Summing Technique for the Detection of $\gamma$-rays*

In the $\gamma$-ray spectrum taken with a single crystal spectrometer, it is not easy to detect the existence of low intensity $\gamma$-rays when there are high intensity $\gamma$-rays in the neighbourhood. In favourable circumstances, the intensity of these $\gamma$-rays, if they happen to be in cascade, can be reduced when studied in a well-type crystal and the peak of the weak intensity line brought out. Secondly the cascade nature of γ-rays can be proved with a single crystal spectrometer with the summing technique.

## 7. P. K. PATWARDHAN (Bombay): *Multi-channel Pulse Analysers*

An attempt is made to review some of the important types of Multi-channel Pulse Amplitude Analysers [ Kick-sorters ], making a critical examination on a comparative basis.

The subject matter on the Kick-sorters will be discussed under the following heads :—

(1) Introductory :—Detecting devices employed in studying Nuclear Radiations such as, Ionisation Chambers, Proportional and Scintillation Counters.

(2) Integral and Differential Bias curves. Their relative importance and how they are used for Nuclear Energy studies.

(3) Single-Channel analysers, their short-comings and need for Multi-Channel Analysers.

(4) Multi-Channel Analysers :

  (a) Basic considerations such as limit to the number of Channels. Prerequisites of efficient Kick-sorters. Factors determining the efficiency of Kick-sorters. They are.

    Stability of Operation,
    Multiplicity of Channels,
    Universality of Operation,
    Linearity,
    Simplicity of Construction, and
    Reproducibility of Results.

  (b) Modern types of Kick-sorters

    (i) Cascaded Discriminators
    (ii) Beam Deflection, Electro-static type
    (iii) Supersonic Delay Lines [Memory Devices]
    (iv) Window Amplifier types
    (v) Height-time convertor method.

  (c) Their relative advantages and disadvantages.

(5) The methods evolved out in our laboratory, their advantages and scope for improvement.

(6) Uses of Kick-sorters in Neutron Physics, Fission reactions, β-ray Spectroscopy, Cosmic Radiation research, Radio-Chemistry, Metallurgy and Medicine.

## 8. RANGALAL BHATTACHARYYA and SANTIMAY CHATTERJEE (Calcutta): *Use of Fast Coincidence Circuits with Fast Discriminators*

Characteristics of fast coincidence circuits along with fast discriminator using secondary emission tubes have been reported. In experiments of angular correlation measurements or delayed coincidence measurements, where fast coincidence arrangements are very essential, the use of fast discriminators has been discussed. A systematic study of various photomultiplier and phosphor combinations along with fast coincidence and fast discriminator circuits have been studied for best performance characteristics. Observations on the long time stability of these arrangements have been discussed.

### 9. N. K. Saha and Narendra Nath (Delhi) : *Determination of Absolute rate of β-ray disintegration from a $P^{32}$-source using the 4π-counter technique*

A preliminary report is presented for absolute measurements of β-ray disintegration rate by using a 4π-type of counter and coincidence method. The simplification introduced in the elimination of the usual source of error of β-ray counting and the present limitations of the method are discussed. A radiophosphorous $P^{32}$-source prepared in the laboratory shows a source strength of $1.6 \pm 0.2$ microcurie per gramme as measured by this method. The probable error involved in measuring the actual disintegration-rate of the source is shown to be better than $\pm 2\%$.

### 10. P. N. Mukherjee, M. K. Pal, M. K. Banerjee and A. K. Saha, (Calcutta) : *Short lens Beta-ray Spectrometer*

A short lens type beta-ray spectrometer has been set up following the calculations of Banerjee and Saha (*Proc. Phys. Soc., B.* **66**, 937, 1953). The spectrometer can measure up to 4 Mev. electrons. It has the following characteristics, *viz.*, external radius of the lens coil—24.0 cm.; internal radius of the lens coil—11.0 cm.; breadth of the lens—16 cm.; chamber diameter—17.8 cm.; chamber length—120 cm.; number of turns of the coil—2593.

The performance of the spectrometer has been checked up using $Cs^{137}$ source. The existence of ring focussing was verified by direct photography. A continuous baffle system is being designed to improve the resolution of the spectrometer, as was shown mathematically by Banerjee and Saha.

### 11. N. Veeraraghavan and P. S. Raju (Bombay) : *Determination of of half-life of $He^6$ with a pulsed neutron source and a ten channel cathode ray tube time analyser*

Formation of $He^6$ by bombardment of $Be^9$ with D-Be neutrons has been observed. The neutron source was pulsed by interrupting the extraction voltage of the R.F. Ion source of a Cockroft-Walton type accelerator, with a motor arrangement. Beta rays from $He^6$ were detected by a scintillation counter and the photomultiplier pulses after amplification were made to intensify the spot of a ten dynode Cathode ray tube type K 1159, whose time base was started at the end of the neutron pulse. Using Behrens formula for exponential fitting, the half-life of $He^6$ was found to be $0{\cdot}83 \pm .03$ second.

### 12. B. V. Thosar and M. C. Joshi (Bombay) : *Conveyer Belt Method for studying Short-lived Activities*

A method is described in which the target material to be irradiated by slow neutrons is spread as a uniform layer on the surface of a conveyer belt, passing over two rotating drums, one of which is coupled to a variable speed motor. At one point the moving belt passes through a cavity in a paraffin block, containing Ra-Be neutron source. At a distance of half the length of the belt from this point of irradiation is the detector, which may be a Geiger Counter for beta-rays or a scintillation counter for gamma-radiation. There is heavy lead shielding between the neutron source and the detector so that the back-ground counting rate is not more than twenty per minute. It can be shown that for such an arrangement, a constant counting rate due to the induced activity is obtained for a given speed of the belt and that it increases with the speed, passes through a point of inflexion and reaches saturation at higher speeds when the half-life of the activity equals the period of revolution of the belt. With the present set-up, in which the two drums are 10 feet apart, it is possible to study conveniently activities of half-life in the range 0.5 sec. to several minutes. The method, in effect, transforms a short-lived activity into an infinitely long-lived one, so that the usual devices for studying the radiations of an isotope can be employed.

Some results on 22 sec. $Ag^{110}$ and 2.3 min. $Ag^{108}$ are described.

### 13. R. Ramanna, G. S. Mani and P. K. Iyengar (Bombay): *Pulse Neutron Technique for the Determination of diffusion and Slowing down Constants of Moderators*

The method consists in determining the time distribution of thermal neutrons in the medium due to a pulsed source of fast neutrons. The theoretical expressions for thermal neutron distributions have been derived on both the age theory and the two group theory.

A pulsed source of fast neutrons is obtained by pulsing the ion source of a Cockroft and Walters type accelerator which produces fast neutrons by the $Be^9$ (*d*, *n*) reaction. A new type of time analyser was used to obtain the time distribution of thermal neutrons from a LiI scintillation detector. The principle of this method is to make the ion pulse at the accelerator target initiate the time base of an oscilloscope and allow the thermal neutron pulses to intensify the oscilloscope spot. These spots are observed by a series of 20 photomultipliers onto which the oscilloscope trace is magnified and focussed by means of a simple optical system. The pulses from the photomultipliers are amplified and fed to 20 scalans.

The experiment was performed with ordinary water and beryllium oxide as moderators. The results with ordinary water are discussed on the basis of two group theory. The diffusion constants for beryllium oxide have been obtained.

### 14. A. P. Patro, B. Basu and B. D. Nag (Calcutta): *Studies with a new design neutron velocity spectrometer*

A neutron velocity spectrometer has been designed and constructed for operation in the region of 1–30 Kev. neutrons. The apparatus utilises two scintillation counters. The first one uses an organic crystal which also functions as a neutron scatterer. The proton recoil pulse from the scatterer is detected. The second scintillation counter detects the scattered neutron and the inverse of the delay time between the second detector pulse and the first is a measure of the velocity of the scattered neutrons. The distance between the two crystals is kept fixed and by counting at fixed delay times between the pulses, neutrons of different energies are detected. Four delay channels are used to obtain four points in the neutron velocity spectrum which are shifted by varying the delay in any channel to any desired value. An eight millicurie $R_aD$ Be source of neutrons were used to check the circuitry and obtain the neutron velocity distribution for this source upto 30 Kev. Using this apparatus total cross-section $\sigma_T$ were measured for Sodium, Manganese, Bismuth and Vanadium. The values of $\sigma_T$ for Sodium and Manganese in the region of 1–10 Kev. agree with the previously observed values in the standard literature. The values of $\sigma_T$ for Bismuth and Vanadium have recently been reported in the literature in this region of energy. Vanadium shows a resonance level at 3 Kev. and Bismuth at 4 Kev.

The heights and widths of these resonance levels have been measured. The advantages of the delayed coincidence type neutron spectrometer is discussed and it is shown that it is feasible to use this type of spectrometer upto 100 Kev. neutron energies and obtain resolutions upto 2% at 50 Kev.

### 15. G. B. G. Taylor (Bombay): *$BF_3$ Neutron Counters*

Some of the problems which arise in purifying boron trifluoride for use in neutron counters are discussed, and some practical suggestions given.

### 16. E. Kondaiah (Bombay): *Slow Neutron Detection*

Methods of detecting slow neutrons using activation methods and the precautions to be taken in estimating the neutron intensities will be discussed. Methods of detecting very low intensities of neutrons will also be discussed.

# THE PROSPECTS OF MANUFACTURING SYNTHETIC LIQUID FUELS IN INDIA

### Section of Chemistry

*Chairman* : DR. S. HUSAIN ZAHEER (Hyderabad-Dn.)

1. DR. A. LAHIRI (Jealgora) opened the discussion and dealt with the general aspects.

2. DR. J W. WHITAKER (Jealgora) : *Types of Coal available.*

Two main processes are envisaged—(1) direct gasification with Fischer Tropsch synthesis, and (2) low temperature carbonisation with hydrogenation of the tar and perhaps gasification of (some of) the soft coke produced again with Fischer Tropsch synthesis. In the paper a review is given of the main types of coal available for such processes in India, including lignites. Attention however is drawn chiefly to the bituminous coals available in Bengal : distinction is made between the *high moisture* coals of the Ranigunj field (including such seams as Samla, Jambad-Bowla and the Kajora) on the one hand and, on the other, the relatively *lower moisture* coals of the central part of the Ranigunj field including Disergarh, Poniati and Sanctoria seams.

In Indian coals, fortunately sulphur is low in amount and presents few problems. On the other hand, the disposal of large quantities of the slack coal from such seams as Samla and Kajora may present serious difficulties unless local power stations or industries can consume such fuel, e.g. as pulverised coal.

The slack coal from Poniati, Disergarh, and Sanctoria seams will not present the same difficulties. The moderately caking nature of these coals will also result in a greater yield of coke suitable for domestic fuel, whereas the high moisture coals are likely to give excessive quantities of coke breeze and small coke below 1", difficult to market.

The economics of utilisation of these two main types of coal is also considered. Probably, the high moisture coals may be produced at ⅔rd of the price of the low moisture coals, and the high moisture coals of West Bengal will be nearer to the proposed site of the plant at Durgapur. On the other hand, if low temperature carbonisation of the coal is to be the main part of the project—with hydrogenation of the tar to synthetic fuels—the low moisture coals will give higher and better yields of products in every way. The problem is thus to balance the price of the raw coals against the value of the products likely to be obtained (a) when gasification and Fischer Tropsch process are adopted and (b) when carbonisation and hydrogenation are adopted.

3. DR. S. HUSAIN ZAHEER (Hyderabad-Deccan) : *Review of Modern Methods of Synthesis Gas Production.*

Ever since the synthesis by Fischer and Tropsch of hydrocarbons from carbon monoxide and hydrogen, about three decades ago, the production of liquid fuels from coal has made considerable advances. The most important criterion for production of liquid fuels at a low cost, competitive with natural petroleum products is the cost of production of pure synthesis gas—a mixture of carbon monoxide and hydrogen—in required proportions. The production of synthesis gas therefore assumes great importance in the manufacture of synthetic liquid fuels and likewise in the manufacture of ammonia and synthetic methanol.

Several processes have been in use for many years for the production of 'water gas' which is mostly a mixture of carbon monoxide and hydrogen. Important developments have however taken place during the second world war in the production of synthesis gas, based on the types of raw materials and the type of plant to be employed and the quality of product to be obtained. Each process has its special features and the choice of any depends on the local conditions.

Some of the more important and competitive processes in commercial use at present are discussed. Processes based on coke and coal as raw materials are compared. The Winkler, Power Gas Corporation, Koppers-Totzek, Lurgi Pressure Gasification, Gaz Integrale and Pintch-Hillebrand processes now in large scale use are critically discussed. Other modern developments are also briefly considered. The suitability of these processes to Indian raw materials and conditions is also discussed.

4. SHRI A. B. GUPTA (Calcutta) (*In Absentia*) : *The problem of mining and handling of coals.*

1. Production of Synthetic liquid fuel has been engaging the attention of Scientists, Mining Engineers and the Government of India for the past few years. This matter came to head just after the last world war. Proposals were considered and preliminary action initiated for implementing the project. Its production from coal and lignite has lately been under active consideration.

2. The report on the preliminary survey of available coal reserves carried out in 1949 by Shri A. B. Dutt of Geological Survey of India throws some light on the quality and possible coal reserves in Bengal and Bihar. The details, however, are not sufficient for launching a project for mining corporations for supplying coal to Synthetic Petroleum Plant. A workable Unit with approximately annual production of 3,00,000 tons of liquid fuel would require 2·5 million tons of high volatile high ash coal with reasonable moisture percentage. This is available in abundance in these areas.

3. Before launching a mining project, it is essential to survey, prospect and undertake closed drilling to ascertain the thickness and nature of coal seams, thickness and nature of supermcumbent strata and determine probable coal reserves.

4. As 8 tons coal will produce only one ton of liquid fuel, economic success of a plant will largely depend on cost of coal, a matter of utmost importance.

5. The plant authorities should control transport of coal from the mines to ensure regular and steady arrivals at the plant site, by any of the following methods :

(i) Conveyors.
(ii) Aerial Ropeway.
(iii) Bottom-open-wagons or Hopper wagons.
(iv) Hydraulic Transportation direct from the mines to the bunker in the Synthetic plant.

6. It is difficult at this stage to forecast with any reasonable degree of accuracy the capital requirements of such a project in the absence of Geological and other necessary data. But some indications may be obtained from the information available out of the enquiries that have been made recently. This estimate, naturally therefore, cannot be accurate but will merely serve as a guide. The capital cost, inclusive of acquiring lands, buildings, Power-House and other civil works is estimated to be approximately Rupees 4 to 5 crores. The approximate cost of production in an open cut mine with an annual output of 2·5 million tons would be a little over Rs. 9/- per ton.

5. DR. A LAHIRI (Jealgora) : *A survey of alternative processes for the production of synthetic liquid fuels.*

This paper represents a survey of the alternative processes for the production of Synthetic fuels *e.g.* motor spirit, aviation spirit, diesel oil, fuel oil, alcohols, etc. The recent development on Fischer-Tropsch Synthesis and the coal and tar hydrogenation has been dealt with. The importance of Diesel Oil in the domain of national transport system has been emphasised and its production by the Fischer-Tropsch synthesis and by the hydrogenation of coal and low temperature carbonisation tar has been discussed.

6. DR.-ING. E. WEINGAERTNER (Bangalore) : *Latest Technical Development and Experiences on the Fischer-Tropsch Synthesis and Progress in Catalyst Performances.*

Three principal methods to carry out Fischer-Tropsch Synthesis in a large scale are now in use (a) Improved fixed bed synthesis, (b) Fluidised bed synthesis and (c) Liquid phase slurry catalyst synthesis.

Improvements in fixed bed catalyst synthesis have been towards intensified utilization of catalysts which resulted in increasing space time yield by increasing the catalyst height in comparison to area with simultaneous increase of linear gas velocity and use of gas recycle thereby decreasing the gas concentration and achieving better heat transfer from the catalyst to the heat exchanger.

Application of the fluidised solids technique for synthesis has shown advantages by the use of cheap iron catalysts and by high efficiencies of catalyst units for production of preferably light hydrocarbons with high olefine and isomer contents. Its ultimate technical large scale application with regard to the prevention of corrosion and erosion is still to be proved and is just now undergoing trial.

Running of slurry phase synthesis has proved to be very successful with regard to heat transfer and selective production of desired products as well as to the possibility of using low carbon monoxide contents of the synthesis gas. Construction and design of reactors as well as management of the plant and exchange of spent catalysts has proved to be rather simple and successful. However, large scale experiences have not yet become available, and the present experiences are based on pilot plant scale investigations.

The common trend in the latest development of Fischer Tropsch Synthesis is signified by the overall introduction of iron catalysts and complete abandoning of cobalt catalyst, used earlier. Iron catalysts show higher flexibility with regard to the composition of products. These have higher olefine and higher isomer contents and appreciable contents of oxygen containing compounds. There is a wider range of flexibility with regard to average molecular weight of the product. Iron catalysts require higher temperatures of 240° to 300°C or more as compared with cobalt catalysts. They need synthesis gas which is richer in carbon monoxide content so that in general normal water gas can be directly applied, without further conversion to higher hydrogen contents. Even blast furnace gases can be used. However, iron catalysts are more sensible to carbon deposition due to superheating.

The technical reactor units used now in synthesis plants produce upto 100 tons of liquid products per day, each unit having its own product recovery plant. As synthesis gas production is the highest cost consuming part within the synthesis process the catalyst itself must achieve highest possible specific yield per unit of gas. Therefore, modern synthesis plants use different combinations of stage systems and recycle systems including methane conversion and carbon-dioxide removal in between.

Also gas refining which earlier consisted in two or three different steps and processes, has now been improved and simplified, for instance, by the introduction of the rectisol process, which removes inorganic as well as organic sulphur and other impurities as aromatic and olefinic compounds simultaneously. Improvements in catalyst performance have been made in avoiding high methane formation by adjusting the usage ratio of the catalyst to the synthesis gas ratio of vice-versa, and the use of cheap catalysts. Improvements in quality of the products have been achieved by the introduction of a simple isomerisation process for petrol production, thus increasing octane numbers from about 45 to 76. High olefine contents make the products specially suitable as raw materials for the production of organic chemicals, as lubricants, fatty alcohols etc. If desired, hard-waxes can be produced with melting points higher than 100°C.

It has been found that iron catalysts are able to activate the shift reaction simultaneously with the synthesis reaction. Due to this activity, synthesis can also be carried out, starting from carbon-monoxide rich gases mixed with water vapours.

Recent investigations in the fundamental reactions have indicated the overall importance of the hydrogenation activity of the catalysts in the formation, distribution and nature of the products in so far as the hydrogen used for hydrogenation has a primary influence of the contents of the primary olefines and paraffins. The absolute value of the hydrogenation hydrogen fixes the average molecular weight of the products as well as their average olefine contents. It also rules the absolute height of the methane formation. Catalysts with high hydrogen activation produce preferably low molecular hydrocarbon with low olefin-contents and simultaneously relative high methane formation. At still higher methane formation, however, preferably light olefines are being formed. Catalysts with low hydrogenation hydrogen activity produce preferably high molecular hydrocarbons with higher average olefine contents, but negligible olefine contents on the extreme molecular side. Catalyst performance can be directed in such a way that methane as the only paraffin is formed, and olefines and oxygenated compounds only, make them up the bulk of the products.

Distributions of hydrocarbons, produced in synthesis, by iron catalysts have been measured, and a common statistical law of distribution has been found. With the help of these findings, it is now possible to predict the complete composition of all the products according to C-balance from simple gas-analytical data.

7. DR. S. M. DAS GUPTA (Delhi) (*In Absentia*) : *Some economic aspects of CO-$H_2$ converter for the production of synthetic liquid fuel by Fischer-Tropsch reaction.*

In this short note, some economic aspects of the various types of converters for the production of synthetic liquid fuel by Fischer-Tropsch reaction are reviewed. This is of particular interest in India in view of the proposed synthetic liquid fuel plant. Apart from the techniques for the production of CO, $H_2$, catalyst, and other chemicals in large quantities, due consideration should be given to the type of converter which can be most advantageously used in India for satisfactory production of synthetic liquid fuel with a greater profit.

Successful operation of the Fischer-Tropsch reaction to produce hydrocarbons from carbon monoxide and hydrogen depends on the extremely close control of temperature. The poor conditions for the removal of heat through the walls of the vessel in the usual fixed bed reactor, led to the dictum of Franz Fischer that no point in a reaction of this type should the catalyst be more than 5-7 mm. from a cooling surface. In German practice, two different types of fixed bed reactors had been evolved under the 5-7 mm. restriction, one for normal pressure operation (1 atmosphere) and the other for medium pressure process (7-10 atmos.). The complexity of the equipment required for the German process is such that the investment is of the order of $7,500—8,000 per barrel (42 gals.) of hydrocarbon produced per day. In American practice, a fluidized catalyst is used and the design requires less than one per cent of the heat exchange surface required by the German design. In the latest American process, an internally cooled unit is used and close control of reaction temperature in the converter is achieved by a hydrocarbon vapourising from the catalyst surface. In this process, the investment is of the order of $3,000-3,500 per barrel (42 gals.) of hydrocarbon per day. It has been estimated that an internally cooled unit should cost about the same as the fluid catalyst unit per barrel of hydrocarbon product per day.

## NITROGENOUS FERTILIZERS—THEIR PRODUCTION AND APPLICATION

*Chairman*: DR. S. HUSAIN ZAHEER (Hyderabad-Dn.)

1. DR. S. HUSAIN ZAHEER (Hyderabad-Dn.) made introductory remarks and dealt with the general aspects.

2. DR. M. G. KRISHNA and DR. Y. VENKATESHAM (Hyderabad-Dn.) : *Production and Handling of Ammonium Nitrate.*

A preliminary description of the reactions and various steps involved in the manufacture of ammonium nitrate starting with ammonia is given.

Different commercial processes used in Europe and America, for the manufacture of ammonium nitrate, *e.g.*, Graining, Crystallizing, Prilling and Stengel processes are described and their relative merits and demerits with respect to economy, ease and safety in operation, types of finished products obtained, material of construction etc., are discussed.

Economic aspects of manufacture of ammonium-nitrate are considered and predesign cost estimates for production of ammonium nitrate are indicated.

The need for diluting and coating ammonium nitrate to render it safe and easy to handle is discussed and various materials used as diluting and coating agents are listed. The suitability of using silt as a diluting agent and silt and bone powder as coating agents is mentioned. Proper conditions for storage and approved methods for the same are described.

Safety precautions to be taken in handling and storage of ammonium nitrate to minimize explosion hazards are dealt with in the light of the past experiences of ammonium nitrate explosions that took place in Europe and America.

3. DR. Y. VENKATESHAM (Hyderabad-Dn.) : *Production and Handling of Urea.*

Basic Chemistry and the various steps involved in the commercial production of urea, starting from ammonia and carbon dioxide are given and the significance of 'once through' and 'recycle' processes is explained.

Once-through process and various recycle processes of commercial importance for manufacturing urea, in use in Europe and America, e.g. Dupont, Montacatini, Inventa, Pechiney, Chemico processes, are described. Comparative study of all the above processes is made with respect to the methods used to recover and recycle unreacted ammonia, the operating conditions, the economy and ease of operation etc. Process requirements for the production of urea by complete recycle Chemico process are given.

Choice between the 'once through' and 'recycle' processes and the criteria governing the same are discussed. Choice of suitable sites in India for the manufacture of urea is also discussed.

The general economic aspects of manufacture of urea by 'once-through' and 'recycle' processes are considered and predesign cost estimates for production of urea by 'once-through' process are indicated.

The need to coat urea with coating agents to minimize its moisture absorption and to render it easy to handle and store is explained.

4. DR. K. SESHADRI and DR. J. GUPTA (Poona) (*In Absentia*) : *Mixed Nitrogen-Potash (N-K) Fertilizer from Sea-bitter, and Ammonium Phosphate (N-P) from Tri-sodium Phosphate.*

In the National Chemical Laboratory, Poona, investigation has been carried out in the last three years on fixation of ammonia with three indigenous raw materials other than gypsum and sulphuric acid. They are (1) sea-bittern of 30° and 35°Be. from marine salt works (2) epsom salt, a byproduct of the salt industry, and (3) trisodium phosphate, a byproduct of Indian Rare Earth Factory at Alwaye.

The process, first developed for fixation of ammonia with sea-bittern, consists in precipitating the magnesium salts of the bittern as basic magnesium carbonate by simultaneous treatment with ammonia and carbon dioxide gases. This results in the formation of an equivalent amount of ammonium salts in solution which on evaporation yields nitrogenous fertilisers. The product obtained has nitrogen content of 22% and potash 4%. Light basic magnesium carbonate and light magnesia are obtained as byproducts. One gallon of 34·5°Be sea-bittern yields 7 lbs. of a mixed fertilizer containing nearly equal amounts of ammonium sulphate and chloride. This provides a useful method for the manufacture of an ammonium sulphate-chloride-potash mixed fertiliser from a readily available material without the use of sulphuric acid.

The process developed for sea-bittern was then applied to a saturated solution of epsom salt with added 8% w/v potassium chloride. 90-93% of the magnesium is precipitated out as carbonate and the mother liquor or evaporation yields a nitrogen-potash fertiliser. (N 17%, $K_2O$ 5%, MgO 0·8%).

The third raw material used for fixation of ammonia is trisodium phosphate. Unlike sulphate of ammonia, here the fixing radical for ammonia is the phosphate, which is itself an important plant nutrient. Our process, different from conventional ones, prepares the product directly from an easily available Indian phosphatic material.

A saturated solution of tri-sodium phosphate is reacted with solid ammonium bicarbonate in a stoichiometric quantity to form a stable reciprocal salt pair system $Na_3PO_4+3NH_4HCO_3 \rightleftharpoons (NH_4)_3PO_4+3NaHCO_3$. By saturating this solution with ammonia gas, the tri-ammonium phosphate is precipitated out as the white crystalline compound $(NH_4)_3PO_4 \cdot 3H_2O$. It is separated by filtration and the mother liquor is worked out to recover ammonia and byproduct sodium carbonate. The tri-ammonium phosphate being an unstable alkaline compound, it is thermally decomposed at 60° to give a stable product. Alternatively, the labile ammonia of tri-ammonium phosphate was fixed as sulphate or nitrate by acid or acid salt ($KHSO_4$) treatment. By such treatment, a number of water-soluble binary and ternary mixtures, varying in the ratio of nitrogen to phosphate and reacting from basic to acidic, are obtained.

The following are the typical grades prepared: 12-36-0, 13-46-0, 14-35-0, 20-30-0, 20-20-0, 10-20-20.

5. DR. PAUL TAG (Poona) (*In Absentia*) : *Facts about Nitrogeneous Fertilisers.*

Every year millions of tons of Mineral Fertilizers are to be manufactured and distributed throughout the world for which huge industries are developed. From the mineral Fertilizers we expect an exact percentage of Nitrogen, Phosphate or Potash and a special structure along with good physical conditions.

In India it is of utmost importance to have good storage qualities as most of the Salts are more or less hygroscopic and by various methods they must be protected against the moisture.

Granules (diameter 1 to 4 millimetre) have been proved superior to dust.

To prevent caking of Fertilizers blast furnace slag and Siliceous Earth have been proved useful.

"Water Capacity" is the quantity of water the Mineral Fertilizer can absorb without being useless. With Calcium Nitrate it is 23% and by ASN it is 9%. But the effect of this can be arrived at by Calcium Nitrate in about 4 days and by ASN in about 23 days under the same conditions.

The development of very slow flowing Nitrogen Fertilizers is still in progress.

In Europe Nitrogenation has not been so popular so far. The Chemical Compounds of N P K Fertilizers are becoming more and more popular in the USA as well as Europe for economical reasons.

Fertilizers with Trade Elements are also of some importance.

6. DR. B. CHATTERJEE (Sibpur) (*In Absentia*) : *Ammonium Chloride as a Fertilizer.*

The nitrogenous fertilizer commonly used in India is ammonium sulphate. The amount of this fertilizer at present manufactured in India is however too inadequate to meet her total requirement. Further, there is the question of availability of sulphur in adequate amounts. Question has therefore been raised as to whether ammonium chloride containing 26 per cent nitrogen could be used as a substitute because requisite supply of chlorine may come from electrolytic alkali plants where the disposal of chlorine is a problem.

The results of elaborate experiments carried out in the U.S.A. and other countries on the use of ammonium chloride as a fertilizer indicate that apart from the fact that the chlorine content of this fertilizer may prove detrimental to certain crops, particularly tobacco, and certain other starch-forming crops, ammonium chloride compares favourably with ammonium sulphate.

Very few experiments on the use of ammonium chloride as a fertilizer appear to have been conducted in India but even then the available data indicate that this fertilizer increased the yield of wheat under both unirrigated and irrigated conditions. It is therefore desirable to carry out systematic experiments to obtain detailed information regarding the effect of continued application of this fertilizer on (i) crop yield, (ii) soil reaction, (iii) calcium depletion in soil, (iv) accumulation of chloride and the resulting toxic effects on crops, and (v) variations in the physical properties of soils, without discarding the use of ammonium chloride as a fertilizer because of the apprehended chlorine toxicity and calcium depletion in soils

7. SHRI K. Z. PATIL (Bangalore) (*In Absentia*) : *Manufacture of Urea.*

Urea being the richest source of available nitrogen, is used in fertilizers. It is also used in plastics and other industries. These applications led to the steady expansion of the manufacture of urea. At present about 2,000 tons of the compound are produced in the world every day. Urea is manufactured by the interaction of carbon dioxide and ammonia under high pressure and high temperature.

The development since 1925 in the technique of industrial process for the manufacture of urea, has been reviewed in the present paper. Six different processes have been employed in different countries. The important aspects of the processes like Montecetini, Pechiney, Inventa and New chemico are discussed. Problems of recovery of unreacted gases and corrosion are also discussed.

Finally, the high pressure manufacture of urea is considered from India's point of view. The necessity, possibility and planning of urea production in India are analysed and discussed.

8. DR. G. V. CHALAM (Bhubaneswar) : *Application of nitrogenous fertilizers in Orissa.*

During the last quarter century a number of trials on the doses of Nitrogen, time of application, and method of application have been investigated all over the country. The trials were conducted upto an upper limit of 120 lbs Nitrogen per acre. In almost all the Agricultural Research Stations, they have struck an upper limit of 20 to 40 lbs N. beyond which the response is not commercial.

In a series of experiments conducted in Orissa with a number of combinations over a number of years 30 lbs N. was found to be the optimum. Even with this upper limit the response is limited to near about 10 lb of grain for every lb of N. under optimum conditions. Thus on the whole there is an increase of 300 lbs grain per acre. One significant fact is that the Straw/Grain ratio increased. This has not brought much response from the ordinary rice cultivators in the application of Nitrogenous fertilizers to Rice. This sets a serious limitation to the utilization of Nitrogenous fertilizers.

In the recent work in Japan studying the response to heavy manuring it was found that the Indica types showed poor response to heavy manuring compared to the Japonica types. Added to the inherent incompatibility, the breeding of the improved types was done strictly under unmanured conditions taking the resources and the temperament of the ordinary cultivator into account. These improved types of indica proved very useful till recent times when the fertilizer industry had not developed. As studied by Bava & others, the varieties which are not responsive to heavy manuring :

1. Had a low ratio of Nitrogen content to the dry matter in plant during tillering.
2. In the parts above the ground they had a wide area of Nitrogen content per individual.
3. They had a short period during which the leaves maintained their assimilative power after earing and were liable to lodge.
4. Absorbed more Nitrogen at the early stages of growth but absorbed less Nitrogen at the later stages as compared with the Japanese variety :
5. Showed a higher increase in the percentage content of soluble Nitrogen with a high ratio of soluble Nitrogen to protein Nitrogen.

On the basis of the above findings Baba explains that indica varieties when grown under heavily manured conditions, the balance between the absortive activity, and the nitrogen assimilation is very much disturbed with an increase in the soluble nitrogen. Consequently there is an increase in leaf area and dry matter of the top at the early stages of growth. This unbalanced relation between the two forms of nitrogen checks further absorption leading to malnutrition of the plant at later stages of growth. Consequently the yield of grain is low in contrast to that of straw.

With the new outlook of the fertilizer industry the selection and breeding of indica types will be new lines resorting more towards panicle-number types with short stalks responsive to heavy manuring, than to the panicle-weight-types suitable to light manuring. The hybridization and breeding of Japonica X Indica hybrids under the auspices of F.A.O. in the Central Rice Research Institute is a land mark in furtherance of the utilization of Nitrogenous fertilizers for the Rice crop.

9. DR. S. D. NAJHAWAN (Ludhiana) : *Application of Nitrogenous Fertiliser in the Punjab.*

Nitrogen, phosphorus and potash are the three major essential nutrients which are required by the plant in large amounts. Out of these the soils of the Punjab respond to nitrogen the most and the application of nitrogenous fertilizers considerably increases the yield of all crops. In field experiments it has been seen that an application of 50 lb of N as ammonium sulphate increased the yield of maize by 7·3 maunds, rice 8·2 maunds and cotton 3·5 maunds. An application of 25-40 lbs of N resulted in an increase of 4-7 maunds in the yield of wheat grains. 100 lbs nitrogen when applied as ammonium sulphate to sugarcane enhanced the yield of gur by 26 maunds and that of chillies by 8 maunds.

In a comparison of the relative efficiency of the different nitrogenous fertilizers such as Ammonium Sulphate, Urea, Ammonium Nitrate and Ammonium Sulphate-Nitrate, Ammonium Sulphate proved slightly better than the rest and urea produced one to two maunds of wheat less than ammonium sulphate.

Ammonia liquor also in field experiments gave a significant increase of 5-6 maunds per acre over the control, though it was inferior to ammonium sulphate. In the pot experiments however it gave as good yields as the other nitrogenous fertilizers.

The inorganic nitrogenous fertilizers were also found to be superior to the organic manures and they have shown some residual beneficial effect, particularly the ammonium sulphate. The continued application of ammonium sulphate for 10 years has not shown any deleterious effect on soils or yields of the wheat crops. The plots receiving continuous application of 40 lbs N in ammonium sulphate have out-yielded the others receiving farm yard manure.

The experiments so far conducted on the method and time of application of nitrogenous fertilizers have shown beyond doubt, that the different fertilizers have got different time of application. Ammonium Sulphate when applied before sowing and ammonium nitrate after sowing of a crop gave the best results. However, this field remains mostly unexplored particularly in the case of Urea, Ammonia liquor-like new fertilizers.

The amount of ammonium sulphate required annually in the Punjab State when it is proposed to apply 26 lbs of Nitrogen to an acre field will be 8,30,000 tons. It means that two factories with the same capacity as the Sindri Factory are required for the Punjab State alone. However, the production of ammonium sulphate in such a huge quantity is not possible. Therefore, some other nitrogenous fertilizer will have to be manufactured. Urea seems to be a very suitable fertilizer as it can be manufactured along with cement. Lime stone is present in adequate quantity in the Punjab and therefore can be used for the manufacture of both cement and urea.

10. SHRI S. K. MUKERJI (Calcutta) (*In Absentia*) : *Fertilisers in increasing production of Aman paddy in West Bengal.*

Increase in production of Aman-pady was tested by statistically designed experiments in the State Farms of West Bengal for a number of seasons. The responses due to Nitrogenous and Phosphatic fertilisers in increasing the yield of Aman-paddy was not similar in all the places. In Ganga Low-Lands, optimum dose of Nitrogen lay between 20-40 lbs. per acre, which could increase the yield on an average by 4 mds/acre. Phosphate did not produce any significant increase. In Lateritic Colluvials, large increases, resulted, by the application of Nitrogen and still larger when Nitrogen and Phosphate were in combination. In Terraced Red Soils over Felsapthic subsoil, increases in yield, due to nitrogenous fertilizer was as high as 11 mds/acre, which could be increased further by the addition of Phosphate. Over Laterite soils, increase in yield of 8 mds/acre of paddy grain could be obtained with nitrogenous fertilisers. Superphosphate could increase the yield further by 2·3 mds/acre. In Damodar-Flat-Land series, nitrogenous fertilisers could increase the yield of paddy by 6 mds./acre and adding Superphosphate increased this yield by another 3 mds/acre. In Ganga Riverine Series Nitrogen increased the yield by 2·36 mds/acre, phosphate could not increase in low doses.

In Tista Riverine Series, the increase of 3·68 mds. of Aman-paddy could be obtained with 45 lbs. of Nitrogen/acre. Phosphate did not increase yield.

11. DR. S. VEDARAMAN (Sindri): *Manufacture of Ammonium Sulphate at Sindri.*

In this paper an outline of the manufacturing process at Sindri together with some of the major technical problems which we faced and the way we tackled them have been given.

We use about 500 tons of coke per day in our semi-water gas plant which is being made by employing the "stamping process" in narrow ovens. This process, introduced for the first time in India enables weakly or semi-caking coals to be used so that we can conserve our reserves of good coking coal.

The coke produced must be reactive and also have high ash fusion characteristics so that gas make is good and clinkering does not happen in the gas generators. The proper bled of coal to be used for making the coke has been arrived at after elaborate investigations and further investigations are in progress.

Efficient removal of hydrogen sulphide from the gas has been achieved by suitable modifications in the oxide box packing and arranging for reversal of gas flows.

The carbon-monoxide conversion catalyst which was being purchased from abroad is now produced at site in a catalyst plant designed and erected by the technological staff at Sindri.

Severe corrosion has been observed in the mild steel water scrubbing towers, water pumps and pipe lines, probably due to the presence of hydrogen sulphide in the gas.

Additional condensers have been provided in the refrigeration section since these were found to limit the capacity of the system.

All the equipments handling strong ammonium sulphate liquor are constructed of stainless steel. Evaporated bodies and the connecting U-bends are of titanium-stabilized 18-8 stainless steel, while the circulating pumps and heater tubes are of Molybdenum based steel. Severe cracking and pitting have occurred in the evaporator bodies and tanks handling hot concentrated sulphate liquor while the Molybdenum based parts are free from corrosion. Elaborate investigations have been carried out to find out suitable corrosion inhibitors.

The deposition of insoluble double salts of calcium and ammonium sulphate in the evaporators and heater tubes is arrested by arranging a purge of the evaporator liquor to the reaction vessels, the double salt getting automatically filtered in the chalk filters.

12. DR. N. N. GODBOLE (Jaipur):

Cost of current alone per ton of heavy water at Nangal is Rs. ten lakhs, taking the cost of current at 2·6 pies per unit. The dilution of ammonium nitrate is a question not yet solved. Punjab clays are not yet found to be suitable. The manufacture of ammonium nitrate and its use is yet very uncertain, for soils in the western parts of India. The use and mixture of limestone with ammonium nitrate is not recommended for the areas of Punjab, Rajasthan, etc.

13. DR. D. PATNAIK (Cuttack):

The study of the decomposition of the nitrates including $NH_4NO_3$ shows clearly that the process of decomposition is a chain machine. Under certain condition the decomposition of $NH_4NO_3$ in the solution can be slowed down by terminating the chain with suitable materials. The explosions which occur are not thermal in character unless the exothermicity leads to multiplying the chain centres whatever they be leading to explosion. The experiments are under progress and in due course the results will be published.

14. SHRI M. N. SADAPHAL (New Delhi) also participated in the discussion.

# POSSIBILITIES OF DEVELOPMENT OF FINE CHEMICAL INDUSTRY IN INDIA

*Chairman* : DR. S. HUSAIN ZAHEER (Hyderabad-Dn.).

1. DR. S. HUSAIN ZAHEER (Hyderabad-Dn.) : *Introductory Remarks.*

The importance of the subject and the urgency of the problem *vis-a-vis* the national economy are stressed at the beginning. Although an exact definition of a fine chemical is difficult and is wanting, it is generally agreed that chemicals produced in small quantities, of great purity and of high price, are considered as fine chemicals. But a fine chemical, when produced in bulk quantities, may be transferred to the heavy chemical category.

The Government of India appointed a Panel of Experts to report on Fine Chemicals, etc., in 1945. This Panel submitted its Report in 1947. Since then, some of the suggestions contained in that Report *e.g.*, the production of DDT, Penicillin, dyes, pharmaceuticals, etc., have been implemented. The Planning Commission has also been fixing overall targets for production of fine chemicals. However, progress in this field has not been very satisfactory due, among other reasons, to the fact that a planned production of the heavy chemicals required for this industry has not been achieved, in spite of the availability of most of the raw materials required.

The types of raw materials needed for the fine chemical industry, their availability and relative importance are next dealt with. Two of them, namely, coal tar and petroleum products have been taken as examples and discussed in detail with figures of production, possible lines of their utilisation etc. The need for stopping the wastage of the gases obtained in the refineries, and the importance of their proper utilisation are emphasised.

The Chemical engineering aspects of fine chemical manufacture, including materials of construction, design of plant, its fabrication, are also touched upon. The necessity of obtaining accurate market data for assessing correctly the development of the industry and its future planning has been indicated.

2. DR. B. MUKERJI (Lucknow) (*In Absentia*) : *Possibilities for the Development of Fine Chemical Industries (Pharmaceuticals and Drugs) in India.*

Generally speaking, industrial development means application of new knowledge either to produce new products whose demands can be foreseen, created or already exist or to improve the existing articles in terms of purity, variety or reduction in prices.

The industries on pharmaceuticals and drugs involve the manufacture of various medicinal preparations which are used by the medical profession in a ready-made form.

India has made some progress in the development of pharmaceutical and drug industry but has not reached upto the mark since, "research", one of the essential aspects of industry, has not been properly looked after. Industrial progress depends on the proper co-ordination of the work of a number of units, *viz.*, research, development, plant design and construction, quantity production and sales and consumer service and the weakness of anyone weakens the entire structure.

Several possibilities for the development of pharmaceutical industries have been discussed. These are:

Manufacture of adrenaline and extractum pituitary liquidum from the glands, suprarenal and pituitary obtained from slaughter houses.

Manufacture of insulin from pancreas and hormones from thyroid, ovaries and testis. As the country is short of raw materials, frozen stuff may be imported from abroad.

Preparation of lecithin and cholesterol from brain materials and improvements of slaughter houses for the proper preservation of animal organs have been suggested.

Possibilities for the manufacture of several vegetable group of drugs like, emetine from Ipecac, glycosides from Digitalis, etc. have been pointed out and particular stress has been given on the production of reserpine from *Rauwolfia serpentina* and *Rauwolfia canescens* in view of the huge assessment of *Rauwolfia* industry in United States (50 million dollars for 1954).

Scope of production of acetic acid from alcohol for the use in acetate rayon manufacture, textile and pharmaceutical industries, etc., oxalic acid from saw dust and *Arjun* bark wood chip etc. have been cited.

Possibilities for the disposal of chlorine bye-product of caustic soda industry in the manufacture of insecticides like D.D.T. and B.H.C. and bleaching powder have been shown.

Necessity for the production of hydrogen peroxide, activated carbon and earths and glycerine from soap industry has been pointed out.

3. DR. R. N. CHAKRAVARTI (Calcutta): *Drugs and Drug Intermediates from Plants.*

While considering the question of production of fine chemicals in India, the problem of preparation of drugs from plants naturally comes to the fore-front as this concerns proper utilisation of our already existing natural resources. Moreover such an industry is more or less independent of the growth of coal tar chemical industry. Amongst the items which should receive proper attention in this direction, particular mention may be made of the following:—

(*a*) Emetine from roots of *Cephaelis ipecacuanha*, (*b*) Colchicin from *Colchicum luteum*, (*c*) Ephedrine from *Ephedra nebrodensis* (or *E. vulgaris*), (*d*) Atropine from *Atropa accuminata* (or *A. belladonna*), (*e*) Ergot alkaloids from Ergot on rye, (*f*) Caffeine from tea waste, (*g*) Digoxin from *Digitalis lanata*, (*h*) Camphor from *Ocimum Kilimanjaricum*, and (*i*) Menthol from *mentha piperita*. It may be mentioned that cinchona alkaloids, opium alkaloids, strychnine and brucine are already in production for a considerable period. The first two are being produced under State control and the last two by Messrs. Smith Stanistreet and Co., Ltd. of Calcutta.

Besides proper cultivation of useful plants it is highly desirable to carry out an extensive general survey of the plants of this country for their useful chemical constituents. Proper attention should however, be paid for finding out not only products which may be directly utilised as drugs but also those which may serve as starting materials for preparation of drugs.

In connection with a survey work of the seeds of Cassia, Dolichos, Lathyrus, Phaseolus and Vigna plants, we find that seeds of *Dolichos lablab* and *Vigna catiang* may be utilised as sources for stigmasterol. In connection with another survey work on the steroid sapogenins of Indian Dioscorea plants, diosgenin has been isolated in unusually high yields from *D. Prazeri* of Darjeeling and *D. deltoidea* of Kashmir. These sources should be properly utilised for the preparation of

**diosgenin. Simplified methods have also been devised for preparation of diosgenin from the yams suitable for large scale production.**

4. DR. B. D. TILAK (Bombay) (*In Absentia*) : *Development of the Dyestuff Industry in India.*

The indigenous dyestuff industry is making rapid progress. By the middle of 1956, India will be producing a substantial portion of its requirement of most of the important groups of dyes. Six fairly large and about a dozen small dyestuff manufacturing units will be in operation by 1956. Unfortunately, with the exception of a few units, most of the others have started only due to import restrictions rather than with a real desire to establish manufacture of dyes on rational lines on a long-term basis. The present indigenous manufacture is largely confined to soluble azo, azoic and solubilized vat dyes and fast salts from imported penultimate intermediates. The dyes produced are often highly priced and are not always properly standardized. The Government of India is naturally concerned about these developments and is contemplating taking effective steps aimed at the speedy and rational growth of this key industry.

So long as the quality of dyes manufactured is good and the dyes are sold at reasonable prices, there is no harm in having several competing units. Some of the smaller units are likely to hold their own in competition with larger units on account of their limited capital outlay and overheads, intimate knowledge of consumer requirements, and their zeal in carving out an independent existence. In fact the dyestuff industry can play a useful role in the small, medium and large scale sectors of the Second Five Year Plan leading to more employment.

Research in pure and applied dyestuff chemistry and pilot plant investigations on the preparation of intermediates, dyes and related products should be undertaken by the indigenous dyestuff industries. They should also sponsor such work elsewhere in University and Government laboratories where facilities are available. In this way, they will be able to hold their own in this highly competitive and dynamic field and will also rid themselves of the tendency to look to foreigners for know-how. The desirability of establishment of a central dyestuff research laboratory financed jointly by the Indian dyestuff manufacturers and the Government may be explored. The scope of the work undertaken by such an organization may be extended later to other organic chemical industries also.

5. SHRI V. B. SHAH (Bulsar) : *Dyestuff Industry in India.*

India's dyestuffs industry is of recent origin. Large scale production of Azo dyes, Sulphur Black, and Stabilized Azoics, is already on hand, and plants to make Vats and Naphthols are nearing completion. In the next few years, India will be making all the important dyes that she consumes. The task before the dye industry is to attain technical perfection in making dyes to keep up with the growing demand of dyes for different end uses, chiefly for the variety of new fibres that are coming out every year, and to supply as complete a range as is economically possible.

As newer plants are set up for the manufacture of organic finished product, the question of intermediates industry is becoming of immediate practical importance. A short survey of synthetic organic industry is given. While there are differences in the historic developments of the intermediates industry in different countries, a study of these developments will help us to understand our own problems. Various angles of approach for the set up of organic intermediates manufacture are considered. It is emphasized that the intermediates industry should be considered as a whole, and considerations given to these different approaches so that a technically efficient industry is established. This is necessary for the ultimate economy of the whole organic industry.

6. Dr. R. C. SHAH (Poona) (*In Absentia*) : *Preparation of Research Chemicals.*

The paper deals with some general observations on the feasibility of the manufacture of fine chemicals in India. It further deals specifically with various aspects of the working of the scheme on the "Preparation of Research Chemicals for India" being worked at the National Chemical Laboratory of India under the Chemical Research Committee of the Council of Scientific and Industrial Research.

7. Dr. S. C. BHATTACHARYYA (Poona) (*In Absentia*) : *Perfumes and Flavouring Agents.*

Perfumery chemicals can be broadly classified under three heads : (i) natural essential oils, (ii) isolates and semi-synthetics and (iii) pure synthetics. These and allied compounds are extensively used for perfumery, cosmetics, confectionery, condiments, beverage and medicinal purposes. They are indispensable ingredients of many essential preparations. Through judicious application of organic chemistry and chemical technology, the aromatic industry has reached a high state of development in the Western countries. The value of the world consumption of perfumery and allied compounds probably exceeds Rs. 300 crores.

India is rich in essential oil-bearing plants, seeds, flowers, leaves, roots, resins, rhizomes *etc.* Animal products like musk and civet are also available in this country. Most of our raw materials are exported, while we import essential oils and aromatic chemicals often prepared from our raw materials. At present an essential oil-finished products industry can hardly be said to exist in India. Our position as regards the manufacture of isolates, semi-synthetics and synthetics is particularly unsatisfactory. Immediate attention should be paid to the planned development of this industry. There is an abundant supply of many useful raw materials in the country. The necessary technical knowledge is also available. Further, much exploratory work has already been done in this direction in the National Chemical Laboratory of India, Poona and in other Laboratories in the country. It should be quite possible to develop rapidly this industry in India.

8. Dr. Bh. S. V. RAGHAVA RAO and Dr. D. V. N. SARMA (Waltair) : *Chemicals from Rare Earths.*

Cerium is the most abundant of the rare earths with a concentration of 46 parts per million in the earth's crust. This is followed by Yttrium, Neodymium and Lanthanum, with abundances in order 28, 24 and 18 parts respectively. In the monazite sands of Travancore $CeO_2$ is present to the extent of 32%, Lanthanum and the other cerite earth oxides amounting to about 28%. Thus cerium is a widely distributed element and greater production should lend to more varied uses. Its abundance compares very favourably with the abundances of other common elements particularly copper (70) and lead (16). The applications of cerium have been so far limited. A small quantity is used in the mantle industry. Larger quantities are used in the pyrophoric alloys, misch metal, kunheim and auer metal of which the first is the most important. It has the approximate composition Ce, (50) La (40) other rare earths (3) and Iron (7) parts by weight. Ceric compounds have a large potential use as analytical reagents and if available in sufficient quantities should very advantageously replace potassium permanganate. Ceric oxide appears to have very profitable abrasive qualities, particularly useful in grinding optical glass. It is understood that the glass takes a better polish and in merely a quarter of the time than when rouge is employed for the purpose. For none of the purposes is it necessary that the cerium should be of a high order of purity. Amongst the other rare earths particularly of the cerite group which are obtained from the monazite of Travancore, dydimia, the natural mixture of praeseodymia and neodymia finds some use in the ceramic industry to give various colour effects and in the manufacture of blue optical glass. Gadoxinium sulphate has been used for the production of low temperatures by adiabatic demagnetisation. By far the most important use of the mixed rare earth fluorides is in impregnating carbons in the A.C. carbon arc. This gives both greater brilliance and durability. For extended uses greater availability and cheapness seem to be the determining factors. The many tones of the rare earth residues left after the recovery of thorium and uranium from the monazite sands could be profitably employed for fractionation and preparation of the desired rare earth material.

*Cerium* :—The ease with which trivalent cerium can be oxidised to the tetravalent state has long been used for obtaining moderately pure cerium. Chlorine in alkaline medium and neutral potassium permanganate, have been suggested. In the latter case the simultaneous precipitation of large quantities of manganese dioxide is a disadvantage. When acid permanganate is employed the oxidation proceeds only about half way. In the presence of the phosphate ion, ceric phosphate is precipitated and 98 to 99% of the cerium can be recovered but the subsequent removal of phosphate is a laborious and expensive process. Electrolytic oxidation of the nitrate and the sulphate gives only 90% completion with no precipitation. In the presence of phosphate 99 to 100% removal of cerium occurs. A method that is under investigation here which appears to show good promise is electrolytic oxidation in the presence of benzoic acid. Mere ignition of the precipitate yields the oxide directly.

9. DR. B. H. IYER (Bangalore) (*In Absentia*) : *Some thoughts on the development of organic fine chemicals Industry in India.*

The paper deals with the following points :

1. What are fine chemicals?
2. History of the progress of fine chemicals industry in foreign countries.
3. Organic fine chemicals.
4. India's needs.
5. Experience gained in the Preparation Section attached to the Department of Organic Chemistry, Indian Institute of Science, Bangalore-3, and
6. Utilization of indigenous raw materials.

10. DR. P. BAGCHI (Calcutta) : *Possibility of Development of Fine Chemical Industry in India.*

If we make a survey of the industrial developments of a country we would find that it has been prompted by either (i) needs of the defence of the country or (ii) day to day needs of individuals.

In countries like Soviet Russia which developed their industries much later than the Western countries, the incentive to industrialisation was given by defence requirements. So far as our country is concerned we have to admit that we are overwhelmingly dependent on foreign countries for our defence requirements. Sooner the situation is altered the better for us.

The Government would do well to publish a list of chemicals as well as their amount, required for defence purposes. This will serve as a great incentive for the development of many industries.

The Drug Enquiry Committee has published a report in which they have enlisted the name of a number of chemicals required by drug industries. Perhaps many more may be required if not today in very near future. Many of the items can be produced in India on a modest industrial scale depending on imported basic chemicals for the present. When our basic industries will be set up in near future, their products will find a ready market. It is the duty of our Government and our industrialists, therefore, to see that such small scale industries are immediately set up. These will not require heavy capital investment and trained personnel are available in the country.

If such data in connection with other industries become available a coordinated and rational programme can be drawn up. While awaiting the establishment of coal tar industries, petroleum industries, acetylene industries, we must try to develop industries for which raw materials are available in this country. Many essential chemicals can be prepared from turpentine and the rosin can be employed for preparing cheap resins for surface coatings. Lemon grass oil can be utilized for the production of citral, ionones and even Vitamin A. Similarly *Rusha* grass oil will furnish us with geraniol and citronellal, and is the source material for citronellol, hydroxy-citronellal. We now export these oils and import the chemicals. We should be in a position to export these chemicals to other countries.

Even oils like castor oil and linseed oil are source of many chemicals used in plastic and aromatic chemicals industries. Americans are importing large quantities of Cashew nut oil from India and utilizing it for the preparation of resins of certain special type. The list can be multiplied.

Ethylene which can be obtained from ethyl alcohol (from fermentation of molasses which we produce a lot) or from petroleum industries (we have petroleum refineries now) can serve as the starting material for a number of chemicals and plastics. Ethylene can be converted into ethylene dichloride which can be converted to polyvinylchloride and polyvinylchloride copolymers *via* vinylchloride. Ethylene can also be converted into vinylidene chloride and then to Saran. From ethylene dichloride we can prepare Thiokol. Ethylene can be directly polymerized to polyethylene by the I.C.I. method or by the Ziegler method. From ethylene we can obtain ethyleneoxide which can give us ethylene glycol, polyglycols which are starting materials for alkyd resins. Ethylene is also one of the source materials for acrylonitrile, an intermediate in the production of some of the soft acrylate resins and an essential component of synthetic rubbers. Then again ethylene can be converted into ethyl chloride which finds important uses as refrigerant and in the preparation of ethyl cellulose used in moulding powders, lacquers, transparent sheets and foils. Polystyrene is now produced from ethylene *via* ethyl benzene. Ethylene should, therefore, serve as the source material for a coordinated plastic industry in this country.

11. DR. S. M. DAS GUPTA (Delhi) (*In Absentia*) : *Necessity for the standardisation of the various grades of fine chemicals for development of fine chemicals industry in India.*

Fine chemicals are manufactured in India and abroad under some descriptions depending on the quality of the product, *e.g.* A.R., G.R., C.P., B.P., U.S.P., L.R., Extra pure, pure, Technical, commercial, L.P., N.F., etc. Our experience shows that although some manufacturers give the analytical results of their products with suitable descriptive labels, many do not give the same. On account of this fact and also for lack of proper official control, it is often difficult to get chemicals of requisite quality, particularly of Indian make. Sometimes spurious and misleading labels are attached and Indian market is at present flooded with spurious and wrongly labelled fine chemicals. It is, therefore, most desirable that the Government should undertake the responsibility of analysing fine chemicals produced in India and properly sealing them with Govt. seals. This will no doubt check the spread of large scale adulteration, stop the growth of manufacturers without skilled chemists, and develop rapidly fine chemicals industry in India, where there are vast natural resources, and highly qualified technologists.

12. **SHRI A. RAHMAN** (Hyderabad-Dn,) : *Market Data For The Fine-Chemical Industry in India.*

Market data is increasingly required for research work, particularly at a pilot-plant level. This data is hardly available in India. In CLSIR, Hyderabad, attempts were made to collect data for different chemicals and processes through journals, general sources of information and individual producers and consumers. Even though the procedure was time consuming and costly it did not yield satisfactory results. This experience, corroborated by others, necessitates that suitable steps be taken for collection and publication of market data, for the research worker and the industry. It can be efficiently done through a proper organisation, need not be too centralised, which undertakes to publish it regularly in some suitable journal and supply it to individual research workers on demand.

The paper analyses the information given by a number of Indian journals, scientific as well as commercial, and shows that inspite of the varied nature of the journals very little information is usually obtainable from them. It also gives four case examples to illustrate the difficulties faced by the research worker and the poor results attained.

In the absence of the Consultant Agencies supplying such data a suggestion for an organisation to collect data and to publish it, is made.

13. **DR. V. N. LUKE** (Bombay) (*In Absentia*) : *Solvents.*

The solvents required for the development of the chemical and allied industries in India may be divided into four main groups.

*Group A* : Petroleum hydrocarbons, principally special boiling point spirits, mineral turpentines (white spirits) and naphthas.

Substantial indigenous production of mineral turpentine and naphthas from coal tar exists with limited production of special boiling point spirits. Consumption is expected to increase rapidly.

*Group B* : Aromatic hydrocarbons, principally benzene, toluene, xylene and aromatic petroleum extracts.

Production facilities already exist and are likely to expand with the establishment of new coke and steel plants.

*Group C* : Chlorinated hydrocarbons.

The possibility of establishing ethylene dichloride production with PVC production is suggested.

*Group D* : Miscellaneous organic solvents including esters, ketones, alcohols, ethers and glycols.

Ample indigenous ethyl alcohol production is suggested as the corner stone for an expanding organic chemical industry and the desirability of modifying excise procedures together with customs duties and dock dues on higher alcohols is stressed.

14. **DR. M. DAMODARAN** (Poona) (*In Absentia*) : *Production of Fine Chemicals by Fermentation Industries.*

Fermentations were among the earliest chemical arts practised, and when with the onset of the century were classified along with industrial chemistry, the processes concerned were those emanating from ancient applications. Well-known fermentations *viz.* production of alcohol and lactic acid justified Pasteur's description of them as "life without air" as they consist of anaerobic metabolism of sugar. The processes that followed soon after such as those of butanol and acetone were also of the same nature. But processes as the production of citric acid and gluconic acid were oxidative in nature. Other oxidative processes that have been established as practical methods in industry are production of itaconic acid and kojic acid and keto-gluconic acid. All these metabolic processes whether involving oxygen or not have, from the very beginning, been subject to competition by synthetic processes, especially in the case of alcohol, butanol and acetone. But for years it has been expected that synthetic processes starting from cheap coal or fuel gas would displace fermentation processes. Surprisingly this has not happened on the whole; though in certain countries like the USA the production of alcohol by fermentation has decreased, actually these countries obtain fermented alcohol by imports from other countries, where raw materials for the fermentations were cheaper for use by suitable organisms.

However, the number of industrial fermentations has increased in recent times because of the specific properties of micro-organisms to carry out specific reactions. Of the specific products which have been obtained from bacteria and fungi the most well-known have been enzymes required for industrial purposes *viz.* amylases for starch splitting and desizing of textile material and proteolytic enzymes used in industries such as leather manufacture and silk. Other enzymes with use in industry and produced from micro-organisms are those with action on pectins etc. Some of the most remarkable applications of enzymes are capable of being produced without isolation of the enzymes by themselves. Three important pharmaceutical preparations are prepared in this way.

The synthesis of vitamin C from sorbitol, according to Reichstein, necessitates the oxidation of sorbitol to sorbose by the bacterial oxidation with *Acctobacter suboxydans*. Again the difficult introduction of oxygen on the 11th carbon in the phenanthrene group, which is required for the synthesis of cortisone, is also most conveniently carried out by suitable micro-organisms. The glucose polymer dextran being now used as a plasma substitute is also similarly produced.

The outstanding contributions to pharmaceuticals by micro-organisms are now among the antibiotics of which Penicillin and Streptomycin are in great use while others are being found to be in increasing production.

Vitamins and vitamin feeds are also now important pharmaceutical products. B vitamins have for long been obtained from yeasts; the outstanding discovery in this field has been the commercial production of vitamin $B_{12}$ and riboflavin produced by fermentative action of suitable micro-organisms.

In these fields microbiological production is not likely to be subordinated by organic synthetic methods, in view of the very large number of micro-organisms that have yet to be investigated and also the advantage of using mutants of known organisms for specific purposes.

In the lively discussion that followed, Dr. S. K. Sircar (Kusunda, Manbhum) and Shri N. Adhikari (Calcutta) participated and put forth their observations with special reference to the availability in the country and the price of basic organic chemicals such as, benzol, benzene, toluene, rectified spirit, methyl alcohol, etc. The possibility of the production of chlorosulphonic acid and other basic chemicals in this country was also surveyed.

Dr. U. P. Basu (Calcutta) summed up the discussions and made useful comments.

# METALLOGENETIC EPOCHS

## Section of Geology and Geography

*Chairman* : DR. M. S. KRISHNAN : *Metallogenetic epochs.*

Since the Cambrian, there have been three important orogenic epochs—viz. The *Caledonian* (in Silurian times), the *Variscan* or *Hercynian* (in Permo-Carboniferous times) and the *Alpine-Himalayan* (in the Upper Cretaceous to Tertiary times). The interval between each pair is about 250 million years.

Each orogeny is indicated by the intrusion of ultrabasic rocks (peridotites, serpentines, anorthites, etc.) followed by mixed gneisses and then by batholitic granite masses. According to the present-day conceptions, as advocated by H. H. Hess and others, the compression of a geosynclinal basin gives rise to a tectogene or a down-folded belt which dips into the peridotite shell below the *sima*, and which is broken through by ultrabasic rock intrussions which rise into the root region. In fact, peridotites and associated rocks are considered to form only in this way and to constitute the earliest intrusions in the orogenic belt. Basic intrusions (dolerites and andesites) are formed in many cases contemporaneously with the later stages in the history of loading up of the geosynclinal basin with sediments or soon after the intrusion of ultrabasic rocks. Granite batholiths result from the softening and melting of the downfolded crust. The residual, mineraliser-enriched parts of the granite magma form the pegmatites which are the latest intrusions of the same activity.

During the Alpine-Himalayan orogeny, ultrabasic rocks, sometimes associated with chromite deposits were intruded in the Upper Cretaceous in parts of the Baluchistan arc and the Himalayas. The orogeny in the Burmese and Sunda arcs was probably slightly later, in Laramide times The granites were formed later, in the lower or middle Tertiary.

Ultrabasic rocks are associated with deposits rich in chromium, nickel, cobalt, platinum metals, canadium, tetanium etc., while the granitic and grano-dioritic rocks are associated with deposits of copper, lead, zinc, silver etc. Pegmatites contain small quantities of minerals rich in titanium, tungsten, columbium-tantalum, lithium, etc., which do not readily go into association with the more common rock forming or ore minerals.

Ore deposits are associated with orogenic activity, with the ultrabasic or acid to intermediate rocks. They are largely or entirely of magmatic origin. Those associated with sedimentary rocks form either during the subsequent sedimentation or may be partly contributed by volcanic activity which may concentrate certain elements from the sedimentary or igneous rocks.

Most of our metaliferous deposits are associated with one of the Pre-Cambrian orogenic activities. If the approximate post-Cambrian interval between pairs of orogenics (i.e. about 250 million years) applied to the pre-Cambrian eras, we should expect several periods of mountain building and igneous intrusions prior to the Cambrian. Our knowledge of the pre-Cambrian rocks is still meagre. We know, so far, of only about three periods of granitic intrusions in India in the pre-Cambrian, but others undoubtedly exist. The age-determinations of pegmatite minerals available so far indicate ages of 1800, 1600, 950 and 740 million years which we may term early Dharwar, late Dharwar, Satpura and post-Erinpura (post-Delhi). The copper deposits of Nellore, Bihar and Rajasthan may be associated respectively with the last three. Detailed studies will reveal the age of these and other deposits in India. At present, however, our data are insufficient.

**DR. K. P. RODE :**

The distribution of Ore Deposits in different geological periods gave rise to the idea of certain favoured epochs being responsible for generation of Ores and were designated as metallogenetic epochs. A further study led to the recognition of an intimate relation between Ore deposits and Orogenitic belts. This peculiar distribution of Ores in time and space led to the classification of Ore deposits as: Archaiads, Palaeoids, Mesoids, etc. corresponding to Algonkian, Caledonian and Hercynian, Alpine etc. The Ore deposits which did not conform with these ages were still attributed to magmatic processes connected with these orogenies and were designated as pre-orogenic, Main Orogenic, late orogenic, post-orogenic etc.

The Suess idea of limited Orogenies was modified by Stille and he postulated as many as 24 orogenies in place of three in the Post-Cambrian period alone and if we see the distribution of these orogenies in time it will be observed that hardly any geological period remains which has no important Orogeny associated with it. This means that orogenic movement has been an almost continuous process being exhibited once here and once there. Would this then mean that Metallogenesis has also been a continuous process side by side with the Orogenesis?

One of the most important results of the study of Ore deposit has been that Ore deposition is intimately related to magmatism, that most metals are derived through one process or another from the magmas-intrusive or extrusive.

The home of all metals is in deep seated magmas in which they occur in extremely small quantities less than 1% and that they get enriched through later and secondary processes.

In any study of Metallogenetic epoch we must try to understand questions like, What is the cause of magmatism? Is it periodic or continuous? What is its relation to orogeny, whether it is the cause or a bye-product of orogenic compression? What is the nature of Ore emplacement? The nature of concentration process whereby the metals occurring in small percentages give workable concentrates. Why are other magmatic bodies poorer in Ores and why no concentration processes have worked in these bodies?

When we study ore deposits of India we find a Distribution od Ores, repeated along certain definite trends:

Gold : Bihar, Kalahandi, Hyderabad, Mysore.
Copper : Nepal, Bihar, Andhra, Rajasthan, etc.
Mn. : Bihar, C. P., Mysore, Goa, Rajasthan, etc.
Fe. : Bihar, C. P., Mysore, Goa, Rajasthan, etc.
Cr. Bihar, Madras, Mysore, Baluchistan.
Coal : Assam, Damodar, Mahanadi, Godavari, Narbada valleys.
Graphite : Assam, Bihar, Kalahandi, Mysore, Ceylon.
Diamond : Panna (Bijawar), Wajra Karur (Cuddapah), and further in Kenya, Rhodesia, S. Africa, W. Africa, Argentina, Brazil.

This repeated distribution can be easily explained by the theory of Sheet movements whereby Ore deposits formed in one geological setting through magmatic activity were later separated through sheet movements along certain trends which are easily made out.

The idea of certain metallogenetic epochs has therefore to be modified to certain extent to explain not only the geological distribution but also geographical distribution.

### DR. DUNN : *Metallogenetic Epochs.*

Dr. Dunn referred to the mineral sequence in Singhbhum. There the chromite deposits associated with the ultrabasic rocks seemed to represent the first phase of mineralisation. There is little evidence on which to base an estimate of the interval of time which elapsed between the chromite deposition and the next period of mineralisation represented by the sequence: apatite-magnetite, copper, tungsten. Although gold mineralisation in Singhbhum had been thought to represent a later stage of the copper mineralisation, there is no real evidence which could be regarded as final.

Magnesium deposits occur both in the iron ore series and in the later Kolhans. Iron ore enrichment in the banded hematite quarzite belongs to several periods —enrichment contemporaneous with deposition of the bandtd quarzites, enrichment in Kolhan times, in Tertiary times, and today, wherever contour and drainage permit it.

Most of India's mineralisation belongs to the Pre-Cambrian. But the Pre-Cambrian represents a vast period of time and almost certainly contains many cycles of sedimentation, orogenesis and igneous activity. We know so little of these at present, that it is early as yet to speculate as metallogenetic periods within the Archean.

## I. ROLE OF GEOLOGY AND GEOGRAPHY IN NATIONAL PLANNING

DR. A. K. DEY (Calcutta) : *Role of Geology in National Planning.*

Geology should find its application in all civil engineering and mining projects of every stage from planning and designing to final construction or development. It can be of the greatest service however, during planning as it can provide advance information regarding the rocks or soils on which any particular engineering works are to be founded, or, on the geological formations to be prospected for minerals, oil or water. The successful completion of engineering projects may indeed, be largely dependent on the extent to which advantage is taken of their geological environments and if they are unfavourable, on the remedial measures adopted after specialist geological advice. Whether it be the construction of buildings, roads, airfields, dams, harbours, canals, breakwaters, barrages and tunnels or the search for water, oil or minerals, or again, the prevention of floods and soil erosion, contact is at once made with the materials of the earth's crust which it is the particular province of the geologist to know and understand. Even the surface topography, which has so much to do with engineering projects, is a geological feature and needs the same careful geological scrutiny as any other problem involved. The geologist is not only concerned with the strength, stability and soundness of the foundation materials but also with those of the stones, sands and clays necessary for construction work.

In the field of mining, after an ore or other valuable mineral is discovered, geological study of the shape and size of the ore body or deposit is essential before mining operations can be undertaken from the most advantageous position at minimum cost. In the development of a mine or mineral deposit a geologist can advise whether the ore will continue in depth with the same grade and quality or again, as to its likely changes, so that treatment and smelting may be planned efficiently. When the reserves of ore approach exhaustion geological help is often sought to prolong the life of the mine concerned.

In planning the development of industries generally, the geologist's knowledge of the country may be of great advantage in matters relating to supply of raw materials, water and constructional materials of all kinds.

It cannot be too strongly insisted that geology is a practical, outdoor, field science and that before a geologist can be expected to act as a consultant, or to give trustworthy advice in planning, he must have been through the hard mill of adequate field experience. There is, in general, a difficulty in obtaining the right type of person for training in a geological career. In India, in particular, planning demands qualifications and experience of the highest order, otherwise more harm than good will certainly result. For geology to be helpful in planning, geologists in India must keep abreast with the advances made in their science and its relations in other countries.

Some examples, particularly the Canadian methods of search for uranium bearing minerals, are cited to illustrate how geology serves in planning mineral development of a country.

### *Chairman*: O. H. K. SPATE (Australian National University): *Role of Geography and Geology in National Planning.*

The essence of geography is its comprehensive co-ordinating approach. The essence of planning is also co-ordination: if it is not to lead to disaster it must be multi-factor--both in the data it needs and often in the ends it proposes. Therefore, both as basic researchers and as co-ordinators, geographers should have a very important role to play in planning at both the national and the regional level.

But this only if they maintain (1) a proper modesty towards other specialists —there must be no loose talk of other factors all "wrapping themselves round scientific physiographical regions" and so on; and (2) on unremitting pursuit of accuracy: there must be no psychology of "she'll do."

Dr. Dey was therefore dead right when he said that without proper training and experience the geologist or geographer could do more harm than good. But it follows that geographical work should be done by geographers, not by economists or engineers "picking up the subject."

One of the major roles of the geographer, as Prof. Chatterjee has stressed, is in the preparation of National and Regional Atlasses. If such compilations, really comprehensive (everything from solid geology to distribution of schools) is to attempted, the geographer is clearly the man to do it. Without the synthesising contribution of a sound geographical back-ground the specialist, however expert in his own field, may very likely overlook some unsuspected but vital fact—or perhaps I should say lethal fact.

This is recognised for example in the planning agencies of the U.K.; in the U.S.A., where the numbers and status of *non-academic* professional geographers have increased enormously in the last few years; and, as is well known, in the U.S.S.R. right from the start. In Australia also this is recognised by the Department of National Development and by agencies in the various States responsible for valuable surveys and atlasses essential for the preliminary judging of priorities.

Beyond this, there is an immense amount of detailed field work in which the geographer's contribution is or should be invaluable: we must break down the idea that the function of academic geography is to teach more teachers of academic geography. Thus in Australia the Land Research and Regional Survey Section of CSIRO has developed an excellent technique by which, for the first time, really scientific analysis is being devoted to the problems of what can be done in the tropical North and how to do it. The geographer is a key man in the survey teams; in Australia as a geomorphologist, for the human geography of a country with 15,000 people in 500,000 square miles is slight, but as the survey moves to New Guinea the need for human geographers with an anthropological bent is being felt.

Then again physical planning and the delimitation of economic regions should have some bearing on the question of the territorial re-organisation of the country. There ought to be a big opening for economic and political geographers here, and the opportunity of the present interest in a new layout of the political units of India ought to be taken to secure reasonably national boundaries. But it is an index of how much we have to do that the report of the States' Re-organisation Committee--otherwise an extremely able document—has two paragraphs headed

"Geographical Factors", which give reasons for not adopting "geographical boundaries"—as if all boundaries were not geographical."

But now a word of warning. We must beware of thinking in terms of *the* geographer as a super-planner capable of doing the whole job out of his head. It is not the business of M.A. students, for example, to tell the Government of India how to run the country as part of their theses. We can justly claim that our subject is basic because of its comprehensiveness : but for that very reason we must remember that the individual geographer cannot possibly know all that he should know, except perhaps for very restricted regions. He must be part of a team of geographers and others.

But as such, the basic skills common to all geographers—especially the mastery of cartographic techniques—and the correlating habit of mind fostered by the study are absolutely essential to all soundly-based planning. We must get a foot inside the planners' door; and having got it there give a hearty shove with our shoulders!

## NATIONAL PLANNING

*Chairman* : BOSE, NIRMAL KUMAR : *Place of Geology and Geography in National Planning.*

Two points are often overlooked in national planning where the chief interest seems to be placed upon producing a required number of kilowatts of power, a certain mileage of roads or canals, and so on.

1. It is suggested that the effect of the introduction of roads or irrigation canals etc. on human *societies be studied,* and then planning done in the light of that knowledge.

2. The emphasis on production may lead unconsciously to an unbalance in the distribution of social power (whether economic or political). Our purpose in planning should be not merely to *produce more* (which we have to do, of course), but also see to it that social power is not concentrated in a few hands and the rest of the people left anaemic (in the matter of power), but so design things that we produce more and also make men full, not turn them into a condition which is comparable to that of satisfied domestic animals.

All planning, we submit, should have the whole man at the centre of our point of view. Man needs material goods undoubtedly, but also something more.

## II. DISTRIBUTION OF POPULATION IN INDIA

1. DR. V. L. S. PRAKASA RAO (Madras) : *Distribution of population in India.*

The true nature of the distribution of population can be better understood through maps, prepared according to the modern cartographic principles, and population analysis implies an analysis of both natural and cultural landscape factors. The purpose of a population map is defeated if the scale and unit of mapping, the range of densities to be mapped and the dot value are not properly selected. A complete analysis of the distribution of population depends on the accuracy and comprehensiveness of the population maps (not one, but a set of maps) which can be classified as primary and supplementary. Maps showing the distribution of total, rural and urban population, both absolute and relative, can be considered as primary, while the supplementary maps show the distribution of houses and settlement patterns. The accuracy of the population may also depend on the nature of the base map.

An accurate and complete set of maps showing the distribution of population in India is yet to be prepared. For the country as a whole, attempts have been made to show the distribution of population on district basis, which is very much generalised and sometimes even misleading. Just to bring out and explain the differences in the distribution of population between the macro-regions of India or even to identify the 'peripheral' distribution of population is only concealing the real intricacy in the distribution and the patterns of population. It is difficult to understand why a crude dot-map and that on district basis was attempted and included in 1951 census report. The crude and highly generalised map is incompatible with the very valuable analysis in the text.

Before attempting to prepare a set of detailed population maps, experiments should be conducted in typical regions, and the final maps should be worked up from the village level, preferably on 1″-4 miles scale, reduced from 1″-1 mile. The quarter-inch maps can be further reduced to million scale.

Based on a few sample studies in mapping the distribution of population, the following conclusions are drawn: (1) Population maps by dots and isopleths on megascopic scales (1″-1 million and 1″-2 millions) bring out the regional differences in densities but not the pattern of distribution, while the maps showing settlements reveal clearly the patterns, and (2) the patterns of population are preserved only on the quarter-inch maps (1″-4 miles). It is emphasised that even in population mapping, what is known as the 'grass-roots' approach should be adopted, i.e., working up from the village level, in which case, the basic work should be done 1″-1 mile and 1″-4 miles scales, and these maps should be reduced photographically.

To conclude, without a detailed population map of India, it is not possible to give an account of the distribution of population, and before attempting to prepare such a map, a number of pilot studies should be conducted in different regions.

### 2. SHRI PRAMATHANATH HORE and SHRI SIVAPRASAD DAS GUPTA (Calcutta): *Some Studies on the Population pattern in India.*

India is a vast country—a subcontinent, and exemplifies diverse types of geographical environment. The environment has moulded the life, activity, and the distribution of population in different parts of the country. We have very meagre knowledge about the distribution of population in the past, for no such records were taken. Some idea about old urban centres are available from the historical records and from the old Sanskrit literature and various other records of travels.

During the British rule the first countrywide census was taken in 1871. In every ten years the population census is made. It gives us an idea about the regional distribution of population. Smaller the regional unit, the more accurate is the idea of population distribution. Much work has been done on this aspect in the last census of India, which is a remarkable one, no doubt, but many things are yet to be done to make a complete and comprehensive study of the population.

A scientific study of the population distribution will involve a study of the number of persons in a region as well as the type of distribution and its relation to both physical and non-physical environment. Buildings and houses may be regarded as one of the expressions of the human responses to geographical environment. Man makes houses to live in and also to serve various other purposes. Hence the houses and buildings will form an index of the distribution of population. In India very little work is done on the population pattern or settlement pattern. This paper attempts to throw some light on the settlement pattern in some of the typical regions of India. It also shows how one type varies from the other. A study of the following regions are made to illustrate the subject.

A. The Ganges Delta Region :
   1. Active delta region.
   2. Moribund delta region.
   3. Upper Bhagirathi Basin.
B. Hilly Region :
   1. High mountainous and glaciated regions of Kashmir.
   2. The Khasi Hills of Assam.
C. Middle Ganges Valley.
D. Cotton Belt Settlement of M. P. & Berar.
E. Tank-Settlement of Hyderabad.
F. The Malabar Coastal Region.
G. The Mysore Plateau Region.
H. Desert Region.

3. MANORANJAN CHAUDHURI (Calcutta) : *Distribution of Population in India.*

Population maps are not ends in themselves. These maps are but means for serving greater ends—in helping to adjust the country's resources to the existing population. The author, in course of his work in connection with the population changes in the State of West Bengal noticed a decline of the same in many parts while it had increased in others. The first countrywide census being taken in 1872, it is difficult to obtain relevant statistical figures of the pre-census period. But reports of Buchanan Hamilton, and others throw good light into the story In the State of West Bengal, in particular there has been a considerable increase in the urban population, while there has been a gradual decline in the rural population. But many areas particularly in Burdwan, Bankura, Birbhum and other districts were very densely populated in the past. It is therefore necessary to prepare relevant maps of the population of the pre-census period preferably by the shade method in order to bring out the population picture of the past. The housing and settlement pattern and other factors may be taken into account in making such a study. It may be pointed out that the past picture would undoubtedly help in future planning and settlement of India's population.

## I. STAIN TECHNIQUE

### Section of Botany

A symposium on "Stain Technique" was held at 2-15 P.M. on 3-1-1956 in the Botany Section during the 43rd Indian Science Congress Session held at Agra.

1. DR. B. M. JOHRI (Delhi University) opened the discussion :

With microtome sections alone it is not always possible to observe the embryo sacs, endosperms and embryos in their entirety. In such cases dissected whole mounts bring out the structure quite clearly. They have to be stained differently than the microtome sections. Occasionally the ovules from preserved material require a pre-treatment and have to be softened with 5 to 10 per cent aqueous solution of KOH and subsequently cleared in lactophenol.

The dissected embryo sacs, endosperm and embryos can be stained with Delafield's haematoxylin, acetocarmine, or cotton blue and mounted in 50 per cent glycerine in the first two cases and in lactophenol in the third one. Delafield's haematoxylin gives good results because the contrast in nuclei, cytoplasm and walls is very pronounced. Acetocarmine and cotton blue produce homogeneous staining and moreover the latter stain usually fades within a few weeks.

To make the slides permanent, the temporary mounts may be sealed with balsam. Another easy method is to stain in aceto- or propiono-carmine, or Delafield's haematoxylin and mount in zirkle's medium to which a little stain has been added. This medium sets firmly, holds the cover slip and sealing with balsam is no more necessary.

The minute size and delicate structure of the embryo sac, endosperm or young embryos are serious handicaps in handling them. These can be got over by sticking them to an agar film (0·5 per cent) on a slide, fixing in formalin-acetic-alcohol for an hour or so, and washing in water prior to staining. Preparations of dissected embryo sacs of *Argemone mexicana* made by the latter method and stained with iron-haematoxylin, counterstained with alcoholic fast green, have retained the brightness of the stain for three years.

However, a method par excellence is to dissect out the living material, mount in dilute sucrose solution, and stain with ·005 per cent neutral red.

These procedures have yielded excellent results in the study of embryo sacs of the Santalaceae, Loranthoideae and Papaveraceae; endosperm haustoria in the Leguminoseae, Cucurbitaceae, Santalaceae and Acanthaceae; and embryos of *Trapa*, Loranthoideae, Santalaceae and particularly of *Isomeris* (Capparidaceae).

2. DR. G. PANIGRAHI (Cuttack) dealt with *certain methods of Cytological staining of ferns and angiosperms* and the following is the summary of his paper :

The staining procedure adopted for root tip sections of ferns for counting chromosomes is the same as outlined by Manton (1950). Gentian Violet rather than Crystal Violet may be used as an alternative stain to Haematoxylin. Haematoxylin stain technique was found unsuitable for *Caltha* whose chromosomes seem to show clumping after the use of this stain. Its root tips were squashed after pretreatment with 0·2% Colchicine. Although chromatids separated from each other at their ends at times, chromosomes were better spread and the centromere did not split unlike the chromatid separation due to splitting up of centromeres after pretreatment with hydroxyquinoline. Fern root tips were generally analysed by squashing technique after pretreatment with hydroxyquinoline (Panigrahi, 1955) which contracts chromosomes appreciably for better spread.

3. DR. M. S. SWAMINATHAN (I.A.R.I., Delhi) spoke on *the acetocarmine method of staining with reference to Cytological studies in plants with small chromosomes*. He said :

In small chromosome plants, lack of proper differentiation by staining between the cytoplasm and nucleus hampers critical studies of meiosis in microsporocytes. The amount of iron added is an important factor in aceto-carmine staining and attempts have been made to standardise the procedure in this respect thereby saving the individual worker from undertaking empirical efforts. Fixing the anthers in propionic-alcohol (3 parts of absolute alcohol and 1 part of propionic acid containing saturated Ferric acetate) for 24 hours and smearing them in propiono-carmine gives bright staining in many members of Graminae with very small chromosomes. The nucleolus is also stained prominently. This technique with slight modifications can be used with advantage by those interested in the Cytology of small chromosome plants.

4. SHRI A. K. SHARMA (Calcutta University) dealt with *improvements in Chromosome fixation and staining*. The following is a summary of his contribution :

The principal lines of progress and the advances in knowledge thus attained on fixation and staining in recent years have been indicated. The works of author and his associates in connection with a number of new techniques have been briefly summarised. Coumarin technique of Sharma and Bal has been recommended for plants with long chromosomes. The same is true for Phenol technique by Sharma and Bhattacharyya and Hormone technique of Sharma and Mookerjea. Aesculin has been suggested for Palms (Sharma and Sarkar). Paradichlorobenzene method has been found to be the most widely applicable one and is specially suited to those with high chromosome number (Sharma and Mookerjea). All these methods have been published from time to time in different journals and these have enabled the authors (Sharma, Sharma and Sharma) to establish a new theory of speciation in vegetatively propagated plants. It has been emphasized that the so called "mutagenic" chemicals can be effectively employed in chromosome analysis if applied in concentrations below the subnarcotic one. Trials with even iron free water (Sharma and Sen) have shown the property of clarifying chromosome structure in certain plants when even the standard prefixatives fail. It is therefore suggested that the change in plasma viscosity, necessary for chromosome scattering can be brought out by any change in the surrounding medium, even in whatever minimal concentration it is changed. Therefore different plants respond to different chemicals, depending on the degree of viscocity change they require for their chromosome clarification. About the staining cum fixing, Orcein/HCl mixture has been considered to be the best, though it may cause fragmentation if the heating is prolonged for a few seconds more.

5. *T. N. KHOSHOO (Amritsar) : *Chromosomes from herbarium sheets of Impatiens.*

The pollen grains of the north-west Himalayan species of the genus *Impatiens* have been studied. They contain at shedding the crescent shaped generative nucleus in prometaphase and a faint tube nucleus. The generative nucleus often remains in that very condition in the pollen of pressed specimens. Riped but undehisced anthers are soaked overnight in a separate solution of Iron acetate in 45% Acetic acid rinsed and squashed with dilute acetocarmine. Preparations are heated several times to boiling and by applying judicious pressure it has been possible to obtain reliable preparations of the species *I. edgeworthii, I. amphorata, balfouri, balsamina, brachicentra, scabrida, thomsoni, amplexicaulis, roylei,* and *sulcata.*

6. *S. S. BHATTACHARJYA (Calcutta) : *Culture of irradiated pollen grains of Impatiens and staining of the chromosomes in the pollen tube.*

Investigations were undertaken to determine the pattern of heterochromatine in the chromosomes of different species of *Impatiens* and to study the comparative effects of X-radiations on them. Out of several species, *I. balsamina* ($2n=14$) and *I. sultani* ($2n=16$) as well as *I. Holsti* ($2n=16$) showed great bulk of heterochromatine in their chromosomes. The pattern of the distribution of heterochromatine in the chromosomes was also varied and different from species to species. Subsequently, experiments were mainly conducted to determine the differential X-ray sensitivity among the definite heterochromatic pattern of *Impatiens* species. The pollen grains after anthesis are already ready for germination. The pollen grains of most of the species germinate in a variety of solutions of sucrose, lactose, etc.

The pollen grains were X rayed after anthesis when all of them were in the same nuclear phase. The schedule for culturing the pollen grains to obtain the best results is given. The experiments in culturing irradiated pollen grains of this species were extended to other plants and consistantly good results are being obtained by employing this technique.

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* Only abstracts were received but persons did not attend.

Mr. Vishnu Mittre (Lucknow) spoke on staining technique used by Palaeobotanists and Dr. Ramanagina Singh (Banaras) on staining of micro-organisms.

Prof. M. Sayeduddin, President of the Botany section summarised the observations made by the various participants and thanked them for their co-operation in making the symposium a success.

## II. MODERN TRENDS IN TAXONOMY

1. REV. FATHER H. SANTAPAU (Bombay) opened the discussion:

There are two common and clearly defined tendencies on the subject of Plant Taxonomy among botanists. (*a*) That what truly and nearly matters is the correct and easy identification of plants by any means, the simpler the better. (*b*) That only through the proper study of plant anatomy, cytology, embryology, etc.. can plants be classified and identified.

These two views are not contradictory. The study of anatomy, cytology, etc., is essential for the proper understanding of plant phylogeny and for the placing of the plant in the proper genus, family, order etc. No system of classification can be built up if those branches of botany are ignored.

In field practice, however, what is needed most is an easy and simple method through which one can arrive at the correct identification of a plant; it matters little how artificial a key is, provided it serves the purpose.

Further even though field systematists will base their identification on gross external characters, it is clear that such characters are intimately linked with and dependent on the cytology or genetic constitution of the plant, its anatomy etc.

In a word intense study of the plant in all its aspects must be continued, as all are needed for the proper identification of species; external characters will continue to be the basis of classification for field or herbarium workers; internal characters will be the basis of phylogenetic systems of plant taxonomy.

2. DR. B. M. JOHRI (Delhi University): *Taxonomy from an embryologist's point of view.*

During recent years embryological data has often been used in solving taxonomic problems. Some evidences on the systematic assignments of *Exocarpus*, *Trapa* and *Butomus* are considered here.

*Exocarpus*: Due to some resemblance with the fossil genus *Sarcopus*, Gagnepain & Boureau (1946, 1947) have included *Exocarpus* in the gymnosperms near the Taxaceae. Lam (1948) places it in the Protoangiospermae along with *Salix* and *Casuarina*. On the basis of floral and stem anatomy, Smith & Smith (1943) and Swamy (1948) regard *Exocarpus* as a specialized genus of the family Santalaceae. Sussenguth (1954) suggests that a study of its embryology is necessary to decide this issue.

P. Maheshwari & Manasi Ghosh (1955; *see* also P. Maheshwari, 1954) have investigated the embryology of *E. cupressiformis* and *E. spartea*. The main features are: fibrous endothecium, 2-celled pollen grains, ovule without any clear distinction between nucellus and integument, monosporic 8-nucleate embryo sac, Cellular type of endosperm with chalazal haustorium, transverse division of the zygote, long suspensor which proliferates to give rise to additional embryos, and a 'naked' seed where the pericarp directly surrounds the endosperm. A comparison with the embryology of other members of the Santalaceae fully justifies the inclusion of *Exocarpus* in this family.

*Trapa*: At various times *Trapa* has been placed in the family Onagraceae (Bentham & Hooker, 1883), in the Hydrocaryaceae (Engler & Prantl. 1924), in the sub-order Trapoideae as an appendix to Onagraceae (Hutchinson 1926), and in a monotypic family Trapaceae (Pulle, 1938). The embryological study of *Trapa bispinosa* (Manasi Ghosh, 1954) reveals that it has a bilocular, semi-inferior ovary with a single pendulous ovule in each locule. The embryo sac conforms to the Polygonum type, the endosperm appears to be lacking, the embryo has a characteristic coiled suspensor and one of the cotyledons of the dicotyledonous embryo remains arrested.

On the other hand, the Onagraceae has an inferior, tetra-locular ovary with many ovules in each chamber, the embryo sac is of the Oenothera type, the suspensor is short and inconspicuous and the embryo is typically dicotyledonous. In view of these features, erection of a separate family Hydrocaryaceae or Trapaceae to include *Trapa* is quite appropriate.

*Butomus* : So far most systematists have included *Butomus* in the family Butomaceae along with *Butomopsis* (=*Tenagocharis*), *Limnocharis* and *Hydrocleis*. Pichan (1946) points out that on morphological grounds the last three genera should be transferred to the Alismaceae and *Butomus* alone should be retained in the Butomaceae.

The most outstanding difference in the embryology of (a) *Butomopsis, Limnocharis* and *Hydrocleis*, and (b) *Butomus* is that in the first three genera the embryo sac is bisporic (Allium type) and five-nucleate (*see* Johri, 1936; 1938a, b) whereas in *Butomus* it is monospori (Polygonum type) and 8-nucleate (*see* Holmgren, 1913; Roper, 1952). Moreover, in *Butomus*, a parietal cell is often cut off. Thus, on embryological grounds *Butomus* stands quite apart from the other genera which closely resemble the members of the Alismaceae. Sunder Rao's (1953) work further confirms that "Karyologically and morphologically *Butomus umbellatus* is distinct and different from the other allied genera of the family." The present evidence, therefore, supports Pichon's realignment and only *Butomus* may now be retained in the family Butomaceae.

Similarly, the embryological data also justifies the assignment of *Cercidiphyllum* (Swamy & Bailey, 1949) to a separate family, the Cercidiphyllaceae; of *Zygogynum* (Swamy, 1952) to Winteraceae instead of Magnoliaceae; of *Alangium* (Gopinath, 1945; Mitra & Datta, 1949) to Alangiaceae instead of Cornaceae; and of *Sphenoclea* (Subramanyam, 1950) to Sphenocleaceae instead of Campanulaceae.

The foregoing account is an undoubted evidence that embryological data is helpful in the solution of taxonomic problems.

3. Dr. H. L. CHAKRAVARTY (Calcutta) : *A study from the Cucurbitaceae.*

The concept of plant classification has been greatly moulded by many facts of plant science opened by endeavours of experimental scientists through decades. The problem taken up by the classical taxonomists covering Pre-Linnean, Linnean and Post-Linnean periods has been attacked from many angles by the present day cytologist, experimental morphologist, anatomist, geneticist, phytogeographer, ecologist, embryologist and palaeontologist with a single central purpose of finding the natural interrelationships of affinity between the individuals or groups of individuals and their origin. The problem is yet a debatable one but facts gathered from the different branches of botany have placed the taxonomist on a sounder footing today, in his attempt to construct a near-the-ideal tree of evolution.

In this discourse, I have stressed how the facts of floral morphology, the pattern of the construction of flower, the so called skeletal structure of the reproductive organs and their mechanism help us enormously to arrive at a reasonable conclusion of interrelationships of plants in the chain of evolution. The vascularization of the floral system points out the real morphology of an organ. In the family Cucurbitaceae the author has shown how the different genera or species are tied up by a somewhat parallel pattern of construction, the evidence of their evolution from a common stock. The arrangement of androecium in Cucurbitaceae in different groups show definite geometrical patterns in the organic floral mother axis.

4. DR. G. PANIGRAHI (Cuttack): *Synthetic Taxonomy.*

Systematic toxonomy is fundamental to the study of Biology. The delimitation of the boundaries of the species following the principle of "typification" is based traditionally on their gross morphology and geographical distribution, but the modern trends in taxonomy are to provide clues to the solutions of evolutionary problems. For this, one must make use of all the significant character differences between two taxa and this must include cytological, genetical, physiological, ecological, anatomical, palynological and biochemical characteristics of the organisms concerned.

5. DR. M. S. SWAMINATHAN (New Delhi): *The Problem of Intraspecific Chromosomic Races in Taxonomic Classification.*

Although polyploidy has been recognised in nearly half the members of the plant kingdom, intra-specific polyploidy has been reported for less than 7% of the species of angiosperms and more than 90% of these polyploid types or chromosome races have been described as distinct species. The following evidence from recent cytogenetic and cyto-taxonomic work has created doubt about the existence of really intra-specific chromosome races in seed-propagated non-apomictic plants. First, chromosome races which were classified under single species have invariably found to be distinct both genetically and morphologically. Secondly, typical autopolyploid plants are almost non-existent in nature except in apomicts. Thirdly, differences in chromosome number often reveal a strong genetic isolation barrier either as a relation cross-incompatibility or hybrid sterility, and fourthly, even allopolyploids derived from hybridization between species having widely different homologies may resemble one or the other of their parental species so closely that they have not been recognised as distinct by taxonomists. The writer's investigation in two tuber bearing *Solanum species* in which chromosome races were identified, supports the view that chromosome races are in most cases distinct species and should be named as such.

The study of intra-specific chromosome races, besides being of taxonomical interest, is also of considerable practical importance in plant indicator studies with reference to various purposes.

6. DR. AMIYA KUMAR DATTA (Calcutta): *Role of vegetative anatomy in Taxonomy.*

It has been realised by taxonomists that a systematic classification based on external morphological characters can hardly be phylogenetic, but in order to be phylogenetic, it should include all evidences derived from morphological, anatomical, cytological, ecological and other studies.

In recent years, the role of anatomy as an aid to taxonomy has been proved to be of special importance particularly where the material is incomplete.

So far, anatomy of secondary wood used to receive more attention than anatomy of other parts of plants; but anatomy of latter was strongly advocated for taxonomic purposes at the symposium of Linnean society (155th Session).

The practical value of anatomical characters have been applied with profit in (1) the identification of commercial timbers, (2) the recognition of species, genera, families and orders of fossil plants and (3) the identification and control of adulteration of crude drugs and food articles of vegetable origin.

The anatomical data provided in literature so far, are yet too meagre and incomplete when compared to mass of external morphological characters. Thus at the present moment the anatomical data, in most cases of taxonomic studies, cannot play their role properly.

In taxonomic studies, characters which may be considered to be of importance must be relatively fixed and non-plastic, and ecological and physiological characters are to be avoided. A contribution of anatomical characters, rather than single one, should be taken into consideration for taxonomic purposes.

The International Association of Wood Anatomists and also Metcalfe *et al* (1942-43) in the Linnean Society Symposium gave outline of the foliar and cauline characters that are to be relied on for diagnostic purposes.

Examples have been cited in the paper in support of the revision of the existing systems of classification with the aid of anatomical characters in addition to morphological and other characters.

Lastly, it may be mentioned that the study of vegetative anatomy of a few species of the family Acanthaceae by the author reveals that the different genera, at least a few need re-distribution and they should be shifted to suitable positions in existing systems of classifications.

7. SHRI R. SESHAGIRI RAO (Botanical Survey of India, Calcutta) :

In spite of the remarkable progress in the study of embryology, cytology, anatomy and other allied aspects of internal morphology, the classical method followed in the study of plant taxonomy, namely, the study of external morphology still occupies a unique place in plant taxonomy and forms the most important basis in the identification and nomenclature of plants. However, it has been accepted that in modern study of plant taxonomy, the value of data offered by the study of various aspects of internal morphology noted above has been immense as subsidiary characters and more particularly in clearing up some of the intricate problems in relation to the specific and generic affinities and sometimes in establishing their status. Classification and identification of plants primarily on the basis of the study of the internal morphology cannot be practical and will end in utter confusion.

An example how the anatomical data have been useful as supplementary characters in the case of much discussed problem of the affinity of *Grewia* Linn. and *Microcos* Linn. and their generic status has been explained, pointing out how much beneficial it would have been if embryological, cytological and other allied data on internal morphology with regard to these two genera are available in establishing their affinity and status once for all.

8. PROF. S. P. AGHARKAR (Poona) :

Prof. S. P. Agharkar pointed out that it is not true to say that all systems of classification are purely based on exomorphic characters, although the external characters do form the basis for taxonomic classification. For field determination, the external characters are very helpful. Other evidences are useful for finding out minute differences and also in distinguishing critical species.

9. SHRI VISHNU MITTRE (Lucknow) dealt with the *value of Pollen morphology in taxonomy.*

10. *DR. T. N. KHOSHOO (Amritsar) : *Biosystematics of Sisymbrium irio* Linn.

*Sisymbrium irio* Linn. is the only species of its genus that grows in the Punjab plains. It is highly poly-typic. So far only one type of hybrid (3x) has either been seen in nature or obtained experimentally. The nature of the isolating mechanisms is being intimately followed. Classical taxonomy recognises all the races under one variable species, *S. irio* Linn. A comparison with the Linnean holotype reveals that it resembles only the hexaploid race. There is ample evidence for its taxonomic revision, and *S. irio*, as conceived under classical taxonomy, should not remain as one unit.

11. *SHRI SALIL KUMAR CHATTERJEE (Darjeeling): *Modern Trends in Plant Taxonomy.*

Plant taxonomy, dealing with the orderly arrangement of plants, arrives at its principles by the method of analysis, comparisons, and contrast and by the method of synthesis attempts to reduce to order what otherwise appears chaotic. It is now gradually becoming clearer and clearer that our observations to understand the principles of taxonomy should not be confined to the laboratory nor to the herbarium only; they should be supplemented by extensive studies in the field, for only in this way shall we learn to appreciate the multitudinous variations which plants exhibit and to appreciate the problems that confront the taxonomist on every hand.

Taxonomic study has among its objectives the learning of the kinds of plants on the earth and their names, of their distinctions and their affinities, their distributions and habitat, characteristics and the correlation of these facets of knowledge with pertinent scientific data contributed by research activities of related fields of botanical endeavour. All these products of taxonomic research are essential to any study of the natural resources of an area, to studies of land potentials, to evaluation of resources of raw materials possibly suited to man's needs in a multiplicity of activities.

Modern taxonomic study shows that it is a science that is dependent on many other sciences and they in turn are equally dependent on it. A taxonomist must have a knowledge of morphology, he must know not only the gross morphology of the plants with which he works, but if he is to comprehend the relationship of these plants he must often be conversant with studies of their embryology, floral anatomy, ontogenetical development and teratological variations. Modern systematists place considerable value on the importance of cytogenetic findings as criteria in delimiting the species and its elements; data of this character have proved to be of inestimable value in demonstrating the presence and taxonomic significance of exceptional chromosomal situations and of breeding behaviour over successive generations. In addition to an appreciation and understanding of the contributory value of morphological, anatomical and cytogenetical findings, modern taxonomic studies reflect the significance of distributional patterns and of more detailed data concerning the extent of normal variation and its causes. All these wider viewpoints demonstrate the increasing dependence of taxonomy on the findings of related sciences; the product of modern taxonomic research is rapidly becoming one of the synthesis rather than of individual conclusions. Recent decades have witnessed a revival of interest in the science of taxonomy; a revival engendered in part by renewed explorations by the recognition that taxonomic groups are biological entities and not merely morphological aggregates, by a re-valuation of phylogenetic criteria in which wholly new concepts of group relationships have materialised, by extended field studies correlating morphological variations with environmental and distributional factors, and by a realisation of the significance of synthesis of all these related data toward the resolution of the problems of systematics in the world's flora.

Taxonomy, in its recent aspect, pays stress to the problems associated with the distributions of plants which again closely relates the migration of plants. Knowledge of plant distribution is pertinent to the determination of geographic areas of origins of species, of genera, and often of families—all factors that are important in determining matter of genetical relationships. These studies in distribution and geography bring taxonomy into the field of phytogeography, the enquiry into why a group occupies the area that it does, how long it has been there, how rapidly it is migrating, and what evolutionary trends it is showing. Studies with this wider viewpoint represent a synthesis of ecologic, genetic and taxonomic aspects leading to a better understanding of a series of common problems.

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* Only abstracts were received but persons did not attend.

Present-day taxonomists recognise that gross morphological characters are not always adequate to provide reliable means of differentiation between features that are of major significance from those of minor significance, or to serve necessarily in the determination of genetical relationship between taxa. This recognition has resulted in the need for a re-valuation of all taxonomic work conducted by earlier devotees of the descriptive method, a re-evaluation that will take into consideration, in addition to the morphological criteria, all other scientific data pertinent to the situation and as contributed by allied botanical sciences. Thus the present-day taxonomy is based on the primary importance of morphological distinctness and affinity, but it is influenced appreciably by the findings of the cytologist, geneticist, anatomist, ecologist and others.

Taxonomy is passing through a closing era of descriptive taxonomy and into an opening era of dynamic systematics. To achieve the goal, modern taxonomists should possess the combined training of a cytologist, geneticist, morphologist, anatomist and ecologist. He should know the correlation of the ecological and phytogeographical factors with the morphological characters. He should know the unlimited opportunity for the bio-chemically trained physiologist who will work in concert with the morphologist, anatomist, and taxonomist on problems of phylogeny of plants at all taxal levels. Modern trends in plant taxonomy demand the teamwork and collaboration of botanists of all disciplines and the considered evaluation of data from all the sources, without any orthodox bias.

In the end, Rev. Father H. Santapau (Bombay), summarised the contributions of the various participants. He said that it is remarkable how taxonomic conclusions reached on exomorphic characters alone have been corroborated by cytological, anatomical, embryological and other characters in most cases. The latter, however, cannot be used before the plant is identified quickly in the field necessarily on the exomorphic characters. All the other evidences can assist to make Taxonomy perfect.

Prof. M. Sayeeduddin, the President of the Botany section, who was in the chair, thanked the participants for their contributions.

## THE RÔLE OF MUSEUMS

PROF. MRS. HOMAI JAL MOOS :

The ideal Museum has been dreamed of but has not yet been built. The ideal Museum presents, in logical order, the entire story of the Universe, the earth and its inhabitants, together with their total relation to each other. Practical limitations prevent such a museum from becoming a reality but the goal is there.

The scientist educator is concerned with the interpretation of nature rather than with its mere presentation. The day of the 1,000 stuffed animals in one long case is gone. The scientist-educator knows that man must see Nature as a whole since he must live as a whole being within its framework. Not only should the museum house the priceless objects of the earth displayed in dramatic settings that amaze and delight all who come to see it, but the Museum should be all things to all men. It should meet the needs of the housewife, the farmer, the industrialist, the teacher, the college student and the child. Each must find, among its offerings, an answer to his questions, an understanding of daily living and an appreciation of his own place in a highly complex and interrelated world.

The Museums in India should stop from producing artistic, historical and scientific side-shows and try to promote a scientific outlook.

My impressions of the Museums which I visited in Europe and America are :

(1) An outstanding feature of Museums in the West is, the emphasis they place on popular education or informal education. In order to reach as large a number of people as possible, extensive educational programmes, both for children and adults are adopted by Museums.

(2) New interests and hobbies are stimulated in many of the visitors.

(3) The rich resources of the museums are made available to class-rooms.

(4) Sound and various mechanisms add attractiveness, thus making the exhibits visible.

(5) The various clubs run by museums play a very important rôle in school, university and adult education.

(6) The live radio broadcasts from the museums are heard by a large majority of people.

(7) The televised shows from the museum bring the museums very close to the people.

(8) The free film and filmstrip shows accompanied by lectures are very attentively heard by a large audience.

(9) The library and research facilities for scholars are gallore.

(10) Service to the community in making them understand art, archaeology, ethnology, applied and industrial art and science, music, rural art, painting etc. are the main features of the Museum.

(11) Buses bring the children to the museum.

(12) The latest word in museums is "Museums on Wheels". The mobile units are a novelty in modern educational technique. The Travelling Trailside Museum of the Cleveland Museum of Natural History serves not only the rural community but hospitals, orphanages, schools and rural colleges. The exhibition trailer is towed by a towing tractor.

Thus the museums of the West through their programmes of popular and scientific education for children and adults contribute to the economic and cultural life of their communities.

In India also a venture in this field is called for.

## I. BASIC NEEDS FOR THE STUDY OF PHYSICAL ANTHROPOLOGY.

### Section of Anthropology and Archaeology.

*Chairman* : DR. M. N. BASU.

1. DR. S. S. SARKAR (Calcutta) opened the discussion :

In India, inspite of nearly half a century of anthropological studies, mainly under the aegis of the various Governments, very little data on physical Anthropology have so far accumulated and the applied anthropologist is handicapped for this absence of data in the elementary problem of personal identification, one of the professed purposes of physical anthropology. Teaching in anthropology is gradually increasing in India and the Universities too, lack in having a uniform curriculum of studies in Anthropology. In the absence of trained personnel, anthropology has been the happy treading ground of amateurs from all disciplines. The basic need is to form a uniform syllabus of studies in the Universities, where every physical anthropologist should have a fundamental background of biology and other sciences of the intermediate standard at least. A good knowledge of Zoology and Comparative Anatomy is essential for a physical anthropologist, Evolutionary outlook is conspicuously absent in the physical anthropology of India for which adequate biological knowledge is necessary. Human Biology or human heredity has advanced very little in this country although they could be of much use in problems of national welfare. Selection of subjects is a basic problem in anthropology and this involves knowledge of certain elementary principles of genetics. Even in 1954, we find in works done in a Government institution, peoples being lumped under a linguistic or provincial title without any regard to mating groups whatsoever.

Teaching at Postgraduate level at the Universities should be more utilitarian and this can only be possible if at the graduate level of studies the fundamentals are thoroughly taken up. An experimental and scientific outlook is the basic need and only those trained in the fundamentals of science should be accepted for Postgraduate studies. It appears that the lack of scientific outlook and training is the main cause of the present dismal position of physical anthropology in India to-day.

2. MR. M. K. NAG (Calcutta) pleaded for the standardisation of somatometric measurements and read his paper.

The present trend of the physical anthropologists is to give more and more emphasis on genetical studies, but it will not be possible to altogether discard the use of physical measurements in the study of physical anthropology. The chief object of taking physical measurements of different groups of people is to make a racial classification of the groups on a rational basis. It is, therefore, essential that the measurements taken by different anthropologists on different groups of people are strictly comparable.

Prof. P. C. Mahalanabis showed in a remarkable paper in Biometrika in 1928 that about 55% to 70% of the somatometric measurements taken by ten renowned anthropologists of the world were quite useless for the purpose of comparison owing to lack of agreement in definitions and technique, although all these measurements (with one exception) were taken after the International Agreement of Monaco on Anthropometric Measurements in 1906. Since then some progress has been made in the standardisation of somatometric measurements and Martin's classical book published in 1928 has helped much in that direction.

India presents a special problem in this respect. It is a vast country inhabited by about 340 millions of people comprising a large number of ethnic groups. It is not possible to make a complete study of the racial classification of the peoples of India on the basis of physical measurements taken by a single anthropologist or even a few anthropologists, however efficient they may be in their technique of measurement or however rigorous may be the statistical methods applied. It needs an exhaustive and systematic collection of comparable somatometric data by a number of trained anthropologists. During the last few years, eminent anthropologists in India have, however, expressed the view that the somatometric measurements taken in India by different anthropologists are not comparable to the desired extent. So it is of primary importance that something should be done in India for the standardisation of somatometric measurements, which is, I think, one of the basic requirements of physical anthropology in India.

The best way to do it is to conduct experiments in which the same characters of the same series of subjects may be measured by different anthropologists independently. These experiments, if conducted in all the anthropological centres of India, will provide valuable data for (i) the modification of the definitions of some characters, (ii) elimination of some characters and (iii) the preparation of a standard list or a series of standard lists of characters. Statisticians may be of help to the anthropologists in this matter. The only instance known to me of such an experiment in India is one conducted in the Anthropological Department of the Calcutta University where three anthropologists took independently the measurements of 4 characters on a series of 50 subjects. It is essential that similar experiments should be conducted on a larger scale in all the centres of anthropology in India.

3. DR. N. DATTAMAJUMDAR (Calcutta) said that standardisation was not possible as all efforts had failed in this direction.

4. MR. SACHCHIDANANDA (Ranchi) held that after a basic grounding in general anthropology at the under-graduate level it is desirable for Universities to specialise in separate branches of the subject.

5. DR. G. R. GAYRE (Saugor) suggested for deep consideration for this and requested the chairman to form a sub-committee.

The chairman Dr. M. N. Basu was glad to announce at the end of the discussion the resolution that was adopted.

'It was resolved that the Anthropology section is disturbed at the lack of co-ordination in the training of students and researchers in this subject and therefore it requests the Indian Science Congress to inform the Government and Universities of this resolution and furthermore it requests the Indian Science Congress to call a conference at an early date for the discussion and drawing up the detailed curricula proposed. Meanwhile a sub-committee has been constituted consisting of—

1. Prof. P. C. Mahalanobis—Chairman.
2. Dr. N. Dattamajumdar
3. Dr. S. S. Sarkar
4. Dr. G. R. Gayre

to frame the initial memoranda for this conference.'

## II. SOCIAL ANTHROPOLOGY AND SOCIOLOGY.

1. PROF. NIRMAL KUMAR BOSE (Calcutta) in opening the discussion said:

In recent years Sociology has tended more and more to deal with abstractions while social anthropology has been concerned more with wholes. There was a time when Sociology under the influence of Evolutionism, tried to frame generalities. Anthropology was also subject to a similar influence; but has swung round to an appraisal of the uniquenesses of specific civilisations.

In India, we have lately been moving along the latter direction (for instance, in the works of Srinivas, Dube, Sarma and others). It may be useful for us not to give up altogether the other approach, but look for generalities as well.

Some work of a more fundamental nature may also be fruitfully undertaken; one such being the influence of social customs relating to marriage on the physical type of the groups concerned.

2. DR. N. DATTAMAJUMDAR (Calcutta) traced the ancestry of anthropology and sociology and said how they co-operated and covered some common grounds.

3. MR. SACHCHIDANANDA (Ranchi) pointed out that the recent trend in social anthropology is to take up problems. Applied social anthropology made anthropologists take up such problems. With tribes disappearing social anthropologists were turning to more sophisticated people. In England the social anthropologists were nearer to sociologists than anywhere else. The schism between physical and cultural anthropologists is complete. In America the tradition of Boas and Kroeber was still being followed. In India we should try to specialise in one branch with an intelligent appreciation of other branches rather than dabble in all the branches. The fences between sociology and social anthro-

pology had vanished and the door opened was interdisciplinary co-operation in social sciences.

4. JYOTIRMOYEE SARMA (Calcutta) (*In Absentia*) :

Social Anthropology is essentially an outcome of the functional school of cultural anthropology and is distinctive from descriptive ethnography, and historical ethnology. The object of social anthropology is to study in details a given society in its entirety by noting the interrelationships of the various institutions within it. The interest of social anthropology lies on the general attributes of that society which, when compared to general attributes of other societies, may lead us to make generalizations on the nature of Society itself.

Social anthropology thus merges with sociology. The latter discipline regards its subject matter to be "human society", or "the group life of man". More specifically, the sociologist studies social relations, social institutions, social processes and social trends. The difference between social anthropology and sociology may be explained only in the light of history. As anthropology has been a discipline which studied non-European peoples, most social anthropological studies have been made of non-European societies. Sociology, on the other hand, although based on the writings of the social philosophers, developed as an empirical science in the studies of American communities and social institutions. Sociology has come to mean the study of urban societies.

In India, studies of tribal and village communities may be said to belong to the realm of social anthropology. But where should the studies of urban India belong? There is no reason as to why such studies should not be called social anthropological, except in the definition of social anthropology itself. Due to the heterogeneity and vastness of urban areas, the urban sociologist is forced to limit his research to selected parts of the city, or to particular urban institutions. But in its emphasis on studying a given society in its entirety, social anthropology leaves no consideration for such sectional studies.

The discussion was rounded off by the chairman Dr. M. N. Basu.

## I. THE PROBLEM OF RURAL HEALTH.

### Section of Medical and Veterinary Sciences.

*Chairman* : DR. SUBODH MITRA (Calcutta).

1. DR. K. C. K. E. RAJA (New Delhi) :

In opening the symposium Dr. K. C. K. E. Raja (New Delhi) stressed the importance and urgency of the rural health problem and pointed out at the outset that 82·7 per cent of the population live in the villages, the average density being 529 persons per sq. mile. He also stated that while the need for rural health development was undoubtedly great, there were many difficulties in the formulation and execution of the necessary measures, the removal of which should be the essential preliminary steps towards successful programme of action in future. He then mentioned about the following important difficulties :

(1) Improvement of health and welfare of the people depends largely upon the financial assistance from the local community but 75 per cent of the villages in India having less than 2000 population and the economic status being low adequate funds would not be available for health, education and other needs of the people. Sparse distribution of population in certain parts of the country makes much more difficult the execution of measures for improvement, such as, personal health services for preventive and remedial care, provision of safe water supply,

proper disposal of human wastes and maintenance of sanitation at a reasonably satisfactory level.

(2) Unwillingness of all types of health workers to live and work in the villages for prolonged periods is another important obstacle to the development of proper services in rural areas. This is largely due to inadequacy of amneties in the rural areas such as, unsatisfactory housing conditions, difficulty of transport, insufficient facilities for the education of children and lack of opportunities for recreational and cultural pursuits etc.

(3) The state of affairs under which a young doctor has to function in a medical institution in the rural areas may appear to him to be wholly disheartening. Lack of laboratory, X-ray and anaesthetic services and opportunities for consultation with specialists which he considers as the essential requirements of modern practice, discourages him to work in the rural areas especially in the absence of any specific training during his medical course which could stimulate in him sufficient initiative, imagination and adaptiveness to cope with the new and unfamiliar conditions in the rural areas. He is always apprehensive of being reduced to the level of quackery practice.

Dr. Raja then pointed out that the health of the individual and of the community was influenced by a variety of factors and that curative and the preventive aspects of medical care formed only one among the many measures that are necessary, e.g. a healthy environment to live in, sound nutrition, elimination of hazards to health associated with employment, facilities for recreational and cultural pursuits and above all, practice of hygienic mode of living. Therefore the proper setting for improved health could only be created by an all round advance in the standard of living and that almost every activity described towards national development had its bearing on the problem of health. He, however, wanted to confine his considerations on some major matters relating to the organisations of services for preventive and medical care to be provided for the rural population. In this connection he gave a brief resume of the national health programme launched under the First Five Year Plan and that which was likely to be launched in the Second Five Year Plan. These, among others, included the national campaigns against malaria, tuberculosis, filariasis and leprosy, provision of health units and maternal and child care plans, a simultaneous approach to the problem of environmental hygiene including water supplies and other sanitary measures. He then briefly described the progress so far done in each of the above projects and he felt that the Government's attempts were proceeding on satisfactory lines.

According to the speaker the above national campaigns for improved health could be promoted only by the creation of the necessary trained personnel of different types. The minimum requirements to push the plan to success are doctors—90,000, nurses—80,000, midwives—80,000, health visitors—20,000, nurse-dais and dais—80,000 and sanitary inspectors and health assistants—40,000 as against 70,000, 22,000, 26,000, 800, 6,000 and 4,000 respectively which would be available in the country by 1956. Besides above the country would need pharmacists, dentists, technicians of various types. Considerable augmentation of medical and dental colleges hospital facilities and training of auxiliary personnel would be needed.

To overcome the difficulties mentioned above Dr. Raja made the following recommendations :

(1) Considerable augmentation of facilities for training of all types of health personnel.

(2) Grant of a special pay for service in the rural areas, provision of local transport and granting of a subsidy towards education of children.

(3) Creation of a special cadre and appointment of full time officers without private practice to undertake both curative and preventive medical care. In this connection, the speaker pointed out that the medical education was the longest

and the most costly of all professional training and that it would be unjust to offer the same scale of pay and emoluments as that of the officers of the administrative services.

(4) There should be rotation of service between the rural and urban centres to avoid discontentment and monotony. Short refresher courses should also be introduced.

(5) The rural medical institutions should be provided with the facilities of laboratory and X-ray plants, at least as a part of long term measures. While the importance of these services cannot be denied the training should be so organised that the medical officer could ordinarily do without them in the rural areas.

(6) The rural hospitals and dispensaries should be linked to the more elaborately staffed and equipped institutions in urban Centres.

(7) The principle of contributory health schemes as suggested by Col. P. C. Datta should be supported and attempts should be made to work it up. In this scheme the annual contribution of the families should be graded up from Rs. 10/- to Rs. 25/-. The amount thus collected should be supplemented by the District Board and the State Government, each at the rate of Rs. 2/8/- per annum per capita for families with income below Rs. 500/- per year and Rs. 2/- per capita for those with income between Rs. 500/- and Rs. 900/- per year.

*Place of indigenous system of medicine in a national health programme* :

The speaker then discussed the place of indigenous system of medicine in a national health programme for rural areas. He said that one point which might be missed by the people was that the existent indigenous systems represented only a state of development of medicine which at one time was at a high level of excellence but the world had moved a long way from that time. On the other hand, modern medicine with the help of all the available resources of the physical and biological sciences attempts to interpret health and disease and promotes measures to cure and prevent sickness and contributes to the advancement of man's general sense of well-being. The extent to which success has been achieved in reducing morbidity and mortality and in prolonging life and in increasing the working capacity is phenomenal and there can be no going back on the progress achieved and the rural population has as much right to ask for the best medical care as the inhabitants of towns and cities. Antimalarial measures, mass campaigns against venereal diseases, the use of newer drugs in tuberculosis etc. have all demonstrated what can be achieved by adoption of modern methods in the field of medicine. He was not, however, in favour of total condemnation of the indigenous systems and he advocated the following five points programme :

(*a*) There should be an adequate provision for research with these systems to incorporate those which prove valuable.

(*b*) Qualification in modern medicine should be made a prerequisite for training in the indigenous system of medicine as adopted in U.S.A. and U.K. for training in Homoeopathy.

(*c*) The Central and the State Governments should declare that modern medicine will be the basis for development of national health services.

(*d*) The practitioners of all indigenous systems should be registered throughout the country, and after a particular date, no others should be permitted to get themselves admitted to these registers except those who fulfil the second condition. Even with this restriction there would still remain a considerable number of practitioners of the indigenous system for about 25 to 30 years to come, to serve those who desire to be benefitted by them.

(*e*) Implementation of the above principles should be carried out on an all-India basis, the necessary parliamentary legislation being undertaken at an early date.

In emphasising the above five points Dr. Raja mentioned about what China had been doing for the health of her people. While she was making use of the practitioners of their indigenous system to provide medical care for those who wanted, she was pushing forward her programme for training personnel in modern medicine and stopped the training of practitioners in indigenous systems. Similar decisions should be adopted by India and those who are already practising indigenous system should be given further training so that they can be employed for preventive health work.

Finally, Dr. Raja stated that the rural health programme should be considered as a part of the total scheme of improvement of life of our village population which includes improved agriculture, diversified employment, better housing, more abundant of food, raising of standard of education and culture etc. Conquest of disease, amelioration of suffering and enlargement of man's capacity to enjoy life etc. are the fitting rewards to be earned by the workers in the field of health.

## 2. DR. SESHAGIRI RAO (Bangalore) :

Dr. Seshagiri Rao (Bangalore) stated that the importance of the problem of rural health in India could not be over emphasized when it was realised that the bulk of the population in India lived in the villages. The subject was difficult to tackle because a number of interrelated factors such as, illiteracy, superstition, ignorance, traditional customs, insanitary environmental conditions, overcrowding and inadequacy of houses etc. were involved leading to mal and undernutrition and high incidence and mortality in malaria, tuberculosis, smallpox, diarrhoea and dysentery, cholera and plague etc. In certain areas diseases like leprosy, venereal diseases, hookworm, guineaworm and so on were prevented. He said that the crude death rate in India was much higher, 16·2 per 1000, than that in the western countries ranging between 8·1 to 11·4 per 1000 and the infants mortality rate was more than 4 times higher, namely, 124·2 (rural), than the rates in western countries ranging between 18·5 to 27·2. In India 42% of the total deaths occur among children under 10 years of age as against only 6% in England and Wales. The maternal mortality rate ranges between 15-20 per 1000 deliveries, the common causes being anaemia, sepsis, toxaemia of pregnancy, haemorrhage and accidents in the latter. He emphasised the great need for maternity and child welfare services to provide both institutional and domiciliary care of the mothers, and mentioned about the great shortage and death of trained midwife in the country. Among the common causes of infant deaths he mentioned prematurity, immaturity, bronchopneumonia and septic rash.

According to the speaker one of the vital rural health problems in India was the problem of nutrition. He said that the diet was not only ill-balanced but short of total calories which averaged 1750 per day as against 2400-3000 calories need and that compared to 1938 consumption of 1976 calories per day the figure had come down to 1625 calories in 1953—a drop of over 350 calories. A survey in the Mysore State revealed that 18% of the population had indications of some nutritional deficiency or the other. Great stress should necessarily be given on food production i.e. agriculture through the river valley projects.

The speaker then dealt with the disease that were causing devastations in the country and were undermining the working capacity. Malaria headed the list and by itself was responsible for 37% of the total deaths and the benefits derived from the national malaria control programme has been phenomenal. For instance, an economic survey in the Mysore State following the institution of control measures revealed that for every rupee spent on malaria control, the return was in the order of 93 rupees. He was, however, of the opinion that as spraying of DDT could not be a continuous process whereas irrigation projects will continue to give wet cultivation area in and around the villages, he would recommend a twofurlong dry belt around each village which he was going to adopt for the Mysore State. Further more, continuous public health measures would be necessary to keep vigilance over the effect of irrigation on the mosquito breeding.

Speaking about Tuberculosis which now stood second in the list he appreciated the B.C.G. Campaign but it lacked follow up programme. In addition to B.C.G. he advocated adoption of other additional measures such as, improvement of nutrition, housing and socio-economic conditions.

The other diseases which the speaker discussed were smallpox, plague, leprosy, venereal diseases, filariasis, hookworm and guineaworm.

Environmental sanitation was another important aspect of rural health problems which required immediate attention. This included provision of water supply, improvement of general sanitation, collection and disposal of night soil, housing, control of food etc. Under the national rural water supply schemes some crores of rupees had been provided but according to the speaker it was not necessary to have very elaborate arrangements to give protected water supply. The ordinary well with stoning, parapet wall, platform and a soakpit was all that was necessary. The main defects of the tube wells was the lack of maintenance to keep them in good working order. Housing with much overcrowding adjoining cattle sheds and lack of proper kitchens and bathing and washing arrangements also required a great deal of improvement.

The speaker also mentioned about the lack of health personnel. He was in favour of establishment of combined curative and preventive medical care through the establishments of chains of health centres. Already the Mysore State which had been doing the pioneering work had 187 primary health units, seven or eight such units would be under a secondary unit and seven or eight such secondary units would be placed under one district. A doctor at the primary centre could be entrusted with all aspects of public health work including the pre-school care, medical inspection of school children, control of epidemic diseases etc. The same idea of providing curative and preventive services by one agency was the basis of the community project and National Extension services Since it was the plan of the Government to cover the whole country with these services it should be considered as a happy augury for the future.

### 3. Dr. A. C. UKIL (Calcutta) :

Dr. A. C. Ukil (Calcutta) suggested that the Government should have the major share in public health activities of our country through an integrated development plan, and accordingly the health centres should be located in the NES blocks. For the success of this plan co-operation of the people and the doctors are essential. He fixed the order of priority and the integrated plan as follows : Food, shelter, clothing, social security, education and health, improvement of socio-economic conditions is more important than anything else. He agreed with Dr. Raja's suggestion about the indigenous system of medicine and believed that medical men would have a large role to play in the context of national planning and the Rural Health Services should be made more attractive.

### 4. Dr. SACKS (W.H.O., New Delhi) :

Dr. Sacks, W.H.O. representative pointed out that the idea of medical relief should be replaced by that of medical care and that a part of the training of medical men should be in the rural area so that they become conversant with the diagnostic skill at the rural level. He also suggested that the health and the social activities be co-ordinated and go hand in hand in the rural areas and that all the resources, should be pooled for the success of these activities,

## II. IMPROVEMENT OF LIVESTOCK IN RELATION TO PUBLIC HEALTH.

### 1. Dr.* P. G. PANDE (Lucknow) :

Dr. P. G. Pande (Lucknow) opened the symposium. He said that the improvement of livestock in the country was linked up with positive health, but no steps had been taken in the First Five Year Plan to improve it. There was a considerable deficiency of protein and particularly of animal proteins in the diet of the Indians. Without the protein food in adequate amount no worker can carry out sustained hard work. He said that hands were not idle but exhausted due to lack of animal protein. Milk was also consumed very little by the rural people because of limited production. Furthermore, the consumption of animal fat had been very little, being replaced by the hydrogenated fat which is merely a vegetable fat leading to fat deficiency. According to him cocogem or Vanaspati in India is dangerous. It causes mental deficiency and hence there is increase of failures in passing of the examination by the present day students of schools and colleges. Improvement of livestock is the answer and the animal husbandry department is lagging behind. There are two problems associated with this improvement viz. animal feeding and prevention and control of zoonosis and breeding.

The speaker then pointed out that for a countryside programme of breeding, 6000 breeding bulls of selective type would be necessary. Foreign bulls might be imported but they have to be kept in the hills. If the country has to depend upon the pedigree bulls which are now few in number it will take 25 years to carry out the scheme. The solution of the problem would therefore be popularisation of *'artificial insemination'*. A single pedigree bull can serve 5000 cows instead of 60-70 in a year. Another point which he wished to emphasize was that the prerequisite for improved breeding was castration of undesired bulls.

In regard to the feeding of cattle, he said that the country was deficient of fodder viz. hay, oil cakes, husks of grain and grains. The cattle should be fed on grains also, in addition to chaffs. Nutrition of cattle is an important factor in the programme for their improvement, and hence new sources of fodder should be explored and supplementary foods must be found out. In Iowa (U.S.A.) pigs are fed on maize. He also said that, besides adequate health measures and disease control, a large number of Veterinary personnel would be needed and for that a two years short course might be implemented. There should be one Veterinary officer attached to each NES Block and one breeding bull for 4-5 villages. With the introduction of artificial insemination for which a suitable diluent would be necessary the number of bulls necessary could also be reduced. In any case, there should be more production of food grains and cereals.

Among the zoonoses the speaker mentioned about brucellosis, tuberculosis, Q-fever, foot and mouth disease, rinderpest etc.

The inspection service in the country is also poor and need much improvement. Milk, meat, fish should all be brought under the general inspection service. In brief a good planning would be necessary for better and large animal production.

### 2. Dr. K. KHAMBATA (Bombay) :

Dr. Khambata (Bombay) said that the aim of improvement in livestock was to mitigate, and wherever possible, prevent the suffering and disease in animals and in so doing, help to ensure the maximum production of food stuff of animal origin and help to prevent animal disease to man. But experience in the field of human and animal medicine indicated the folly of concentrating on prevention of disease alone, as it would only build large undernourished and unproductive stock. In this connection he pointed out that the more the animals were removed from the state of nature, in order to increase their productivity, the more numerous were their bodily-ills. The aim of animal husbandman should be to secure for our animals under conditions of domestication, the maximum amount of freedom from disease and at the same time adhering as closely as possible to the conditions under which the maximum production can be obtained at the lowest possible cost.

He then described a general policy for the improvement of livestock indirectly ensuring public health under the following five headings. (1) Sanitation and hygiene, (2) Animal nutrition, (3) Hygiene of animal breeding, (4) Prophylactic measures against zoonosis and (5) Prevention of transference of animal disease to man. The speaker finally stressed on the importance of milk and meat inspection.

3. DR. S. G. IYER (Izatnagar) :

In presenting his view point on the subject S. G. Iyer (Izatnagar) stated that by livestock as he understood included domesticated animals of economic importance and poultry comprising of chickens, ducks, geese, guinea fowls, pigeons etc. He felt that livestock industry was one of the sadly neglected subjects in India although for child and maternity welfare, for invalids and for the existence of man improvement of live stock was of paramount importance. He said that due to the acute deficit in the supply of protective foods of animal origin the average health of the man in the country was below par, longevity was short and infant mortality very high. The two departments medical and veterinary could solve the problem by working in close liason and collaborated researches as planned by W.H.O. and F.AO. in case of rabies, brucellosis etc. The application of advanced knowledge of pharmacology, preventive medicine and nutritional researches upon one or more species of livestock have largely contributed to the welfare of man; adrenaline, insulin, pituitrin, pepsin and various other hormones obtained from livestock have been in great demand. According to him the two allied sciences are so close to each other that he would advocate combined education in subject like bacteriology, immunology, etc., as in the universities like Cambridge, Liverpool etc. The health of the community should be protected by adequate production of milk, meat and eggs which required in turn the improvement of livestock.

As estimated by Dr. Iyer India produces 53 eggs per bird per year as against 120 eggs in other countries. Besides the number of poultry birds being small the egg production is much too small. The same is the case with dairy products inspite of large stock of cattle, the total milk production being less than 5 oz. per day and 8 eggs per capita per year as against one pound of milk and one egg a day per person in the western countries. Dr. Iyer, however, wished to assure our countrymen that there was nothing to despair. Our cows, buffaloes and poultry do not seem to lack the genetic make up for better production and return. Only they should be fed well for better production. He recommends mixed farming as the solution for the general improvement for our stock as well as our own economic condition. There should be enough pasture land for the cattle, and adequate machinery should be set up to improve and help poultry development through demonstration centres and by 1961 he would expect the egg production to be raised to 31 eggs per capita as against 4, 6 or 8. One egg per day per capita is possible in India.

He, however, pointed out another aspect of the problem and that is, the production should be followed up by devising of the methods of preservation and conservation of animal products as most of the products like meat, eggs etc. are quickly perishable. Eggs treated at 130°F. for 20 minutes keep them edible for a long period.

He also pointed out that to prevent diseases in the livestock cheap and better vaccines should be produced. There are a large number of bacterial, viral, helminthic, protozoal infections and ectoparasitic diseases from which the cattle and poultry in our country suffer. Adequate measures should be taken and provided for in the 2nd Five Year Plan to protect the livestock from these diseases. The supply of clean milk, meat and eggs free from microorganisms may be the responsibility of the veterinary profession but a closer collaboration with the public health department would be necesasry to deal with the problem effectively. The improvement of livestock did not receive much attention in the First Five Year Plan but Dr. Iyer hoped that this subject of vital importance would receive due consideration in the 2nd, 3rd and subsequent five year plans.

4. DR. S. BOSE (Izatnagar) : *Poultry improvement in relation to public health.*

Dr. S. Bose (Izatnagar) in his speech emphasized upon the development of poultry keeping and poultry farming. From the stand point of problem and vitamin foods which are very deficient in our country egg production ranks only second in the efficiency of animal food production next to milk. These two protective foods supplement each other nutritionally forming an ideal combination of high quality diets. The poultry meat supplements another important vitamins viz. nicotonic acid which is poor in milk and eggs. Large production of the three things mentioned above is further justified to overcome the cereal shortage in our country. Dr Bose also felt that through the establishment of large scale poultry development scheme at the end of five years, he expected to have 31 million pure bred hens to give us 100 eggs per bird annually and at the end of 7 years it would be possible to provide the country with one egg per capita per day. But along with the poultry improvement, a prolonged intensive consumer education programme would also be required to overcome the prejudice against consuming eggs and to educate the public to the value of eggs, even infertile eggs, in balancing up cereal diet.

5. DR. A. C. CHAUDHURI (Calcutta) : *Improvement of supply of milk and milk products in relation to public health.*

Dr. A. C. Chaudhuri (West Bengal Veterinary College, Calcutta) expressed his view points on milk and milk products, as one of the most important sources of food for all civilized nations. He said that more highly developed and prosperous the people the greater was the consumption of milk and dairy products. The minimum nutritional requirements of our people is 16 oz. of milk or milk products per head per day, but inspite of our 178 million cattle India produces only 6 oz. as against 40 oz. in Denmark, 45 oz. in Australia, 35 oz. in U.S.A. and 39 oz. in U.K. There is thus shortage of milk and whatever is available is very dear and adulterated before it reaches the consumers. He further said that with large number of cattle and deficiency of fodder there was no scope for improvement in number. What was necessary was the reduction in number and improvement in quality. This cannot be achieved by mere writing. There must be forceful demands from the public, and the medical profession can do a lot by focussing the public attention.

He also recommended the following steps for safeguarding the quality of milk in the market.

(1) Rationalisation of methods of milk production and marketing on a collective and organised system.

(2) Detection and control of infection and diseases in the herds.

(3) Proper arrangements for processing, cooling and distribution of milk soon after production.

(4) Quality control of market milk.

At the close of the discussion on the two symposia mentioned above the members present tabled and passed six resolutions arising out of the deliberations.

## LIVE STOCK IMPROVEMENT IN RELATION TO PUBLIC HEALTH

1. D. P. SADHU (Calcutta) :

Health is more a positive entity today than in earlier days when pathology reigned supreme and health was more of a negative entity in being able to either cure or ward off a disease. Today public health aims at a state of well-being with positive nutrition. This statement applies more so to livestock. In India it hardly pays to spend money for curative treatment and attempts are being made to pay more attention to prophylaxis and still more so to animal production. Improvement of livestock and public health will go hand in hand, since public health will depend on nutrition, and our livestock is the best source of animal protein to man. Inspite of all attempts to tap the resources of ocean, livestock remains predominantly the source of nutrition to man and as such for improvement of public health. In this discussion more stress will be put on the role of milk. All the constituents of milk are useful for the normal nutrition of man. Although a large amount of skimmed milk was being thrown in the gutters in U.S.A., it has now been found to be a good source of nutrition and is wasted no longer. Milk protein is not only a good source of APF which is usually so deficient in the diet of an average vegetarian Indian, but it contains a good deal of methionine, an amino acid needed as a lipotropic agent. Recent experiments have shown the choline-sparing and lipotropic effects of lactose in rats fed on excess of cystine to induce fatty liver. These observations go a long way to show that the nutritional hepatomegaly in Kwashiorkor in African children weaned so early and also in children of many poor families in India where milk cannot be provided to babies is really due to absence of lipotropic factors of milk in the diet of these babies. This shows the great importance of milk as a source of good nutrition and the improvement of public health. The average milk yield of our cattle is so low that it is uneconomical to feed concentrates to them. It is high time to produce better animals with higher milk yield if the Indian standard of living has to be raised to a level at par with that of our neighbouring countries.

### Section of Agricultural Sciences

## I. SOIL SURVEY, ITS TECHNIQUE AND APPLICATION

### Importance of Clay Mineralogical Studies in Soil Survey

1. B. CHATTERJEE (Sibpur) :

The main object of Soil Survey is to evolve the best method of land utilization under certain sets of soil and climatic conditions. The soil itself therefore plays a very prominent role in soil surveys because the physical, chemical, electrochemical and engineering properties of soils determine their suitability for specific use. Systematic and painstaking investigations undertaken all over the world have proved beyond doubt that the properties of soils are dominated to a large extent by the nature and amounts of one or more members of a certain group of secondary silicate minerals, known as clay minerals, present in them. The retention and release of nutrients, swelling and shrinkage, retention of moisture, plasticity, viscosity, permeability, etc., are some of the properties on the basis of which the soils are classified into different Land Capability Groups. All these soil properties are closely related to clay mineralogy. It is obvious therefore that in any scheme of Soil Survey run with the object of evolving under existing condition the best method of soil and crop management, there should be adequate provision for getting detailed information about the clay mineralogy of the soils.

2. **S. V. GOVINDA RAJAN** (Bangalore) :

The main purpose of soil survey is to make an inventory of soils in the form of a map, accompanied by a descriptive report on the characteristics of the soil and their crop adaptability. Though soil surveys serve utilitarian objectives, the scientific studies involved are inseparable. Soil surveys made for land use and management, as most of them are, must be practical, but they will not be practical unless they are scientifically sound.

Soil survey involves a study of the surface and profile characters, the former giving a picture of the geography, topography, the soil-water relationship, and conditions of vegetation both natural and cultivated, while the latter gives an insight into the nature of parent material, the processes of soil formation, as evidenced by profile differentiation and development of special features within the depth of the soil matrix. A scientific study of the physical aspects of the soil involve classification of colour, texture, structure and consistence besides relating them to landform, relief and drainage. The Chemical aspects of the soils would involve study of their reaction, and detailed study into their mineral and plant nutrient composition and organic matter content, besides investigations into abnormal features like presence of saline and alkali materials in the soil profile. Based upon these data the correlation of the soil groups require to be made followed by the actual mapping.

The assessment of the soil and crop resources of a state or country by such maps is as valuable to the state as the assessment of its natural resources of fuel or mineral wealth to which considerable and careful attention are normally given by civilised Governments. Soil surveys besides enabling work of a fundamental nature in the area, provide for study on important problems on best adaptation of crops to soil, the best method of maintaining or restoring soil fertility, the proper ways of reducing land threatened by the development of alkali and the general study of the soil and crop resources of the entire country. The potentiality of soil surveys as a means of providing information on the susceptibility of differing soils to damage from soil erosion are also obvious.

3. **S. P. SINGH TEOTIA** : *Soil Surveys for Soil Conversation in the Damodar Catchment.*

The paper describes the technique of soil, erosion and land utilization survey and mapping for soil conservation. Such surveys depict soil conditions, extent and degree of erosion and the present land use pattern within a catchment, which will give a picture of the magnitude of the problem of soil conservation and provide a sound basis for soil conservation planning. The paper discusses the merits and demerits of various available base maps for soil survey. Village maps on 16 inches to a mile scale, after cadastral survey are used as base maps for soil conservation surveys since village has been taken as the unit for soil conservation work.

Soil profile is the basis of soil mapping. The selection of profile sites, the frequency of profile digging and the soil characteristics noted in the description of soil profiles have been dealt. In mapping the degree of erosion a "reference profile" is selected after due consideration of Micro-relief and sheet erosion is estimated by weighing other profiles of the same type in the area with this reference profile. In case of gullies, frequency and depth of gully heads etc. are mapped.

A soil map for soil conservation presents the details of soil depth, slope, soil texture, permeability, soil reaction, external drainage pattern, depth of gully heads, erosion and prêsent land use classes by symbols and colours according to the mapping legend. These maps are accompanied by a report giving the analytical data on soil samples, and the description of type profiles.

The land capability classes developed for use in Damodar Catchment and the preparation of proper land use maps from an appraisal of such surveys have been described. Finally the paper gives the outline for preparing detailed working plans for soil conservation and erosion control on the uplands, gullied lands and denuded forests.

4. A. D. DESAI (Hyderabad) : *Notes on Profile Morphology of the Regur Soils of India.*

It is known to soil scientists in India that up till now whatever soil surveys have been conducted in different States of the country, they have not been done according to any standard technique applicable to the whole country. Especially, the descriptions of soil profile-morphology followed in various States do not generally conform with the accepted hypothetical soil profile comprising of A, B & C horizons as described by Kelloge (1936). Recently Satyanarayana (1951) has in some cases of profile studies, described soil morphology on horizon basis and he is inclined to name the horizon containing gypsum as "B" horizon, although there are deviations in his descriptions. Most of the soil workers in India have described soil profiles on depth basis such as 0-6", 6-12" and so on without any reference to A, B, and C horizons which are the accepted bases for the scientific descriptions of soil profiles.

Recently however, some confusion has been created regarding the morphology of black cotton soil or "regur" soils of India by the publication of an article on the subject by Simonson (1954). This author has described six Indian regur soil profiles, three derived from trap rock (basalt), the fourth from limestone and the fifth and sixth derived from alluvium or colluvium In the descriptions, he has named the surface horizons varying in depth from 10 to 38 inches as parts of 'A' horizon and all the lower depths as parts of 'C' horizons, without any reference to 'B' horizon. Evidently his descriptions must have been based on the assumption that regur soils are always developed on transported material because without exception he has described the heavy subsoil layers as 'C' horizon, i.e., parent material. Besides, according to the present concepts of soil morphology, the zone of lime accumulation in the regur soil should form a part of illuvial or the 'B' horizon; but the author has altogether overlooked this aspect and has included the lime and salt accumulation zone also in 'C' horizon.

From the studies of regur soil profiles in Hyderabad State, it is seen that in the case of sedentary soils derived from non-calcareous rock formations chiefly from basalt and granite, the lime accumulation zone occurs at some depth and the 'C' horizon or the disintegrated rock or muram is quite free of lime. Such conditions, I believe, occur in many parts of India and they clearly indicate that the lime accumulation zone with its parent horizon is an illuvial horizon and it should be differenciated as 'B' horizon. Presence of gypsum or salt concentration zone usually occurs in association with the lime kankar zone especially in deep regur soils. Thus accumulation of salts and lime in regur soil profile definitely owe their origin to the action of soil forming processes as stated by Hosking (1935) in his comparative study of the Black Earths of Australia and the 'regur' of India.

Another point which seem to create confusion among the Indian workers is the nomenclature of the 'A' horizon in our soils. In the hypothetical soil profile described by Kelloge (1936), this horizon comprises of four divisions such as $A_{00}$, $A_0$, $A_1$ and $A_2$ in the descending order of their organic matter contents and only the '$A_2$' horizon corresponds with the surface layers of most of our soils excepting the forest and peaty soils wherever they exist. So in our soil profile descriptions especially in arid and semi arid tracts, the surface horizon may conveniently be termed as '$A_2$' horizon if we follow the hypothetical soil profile descriptions. But it is found that we have not formed any clean cut idea about such nomenclatures.

From the above considerations it is clear that there is need of thorough discussions and decisions regarding the ways and methods of soil descriptions under Indian conditions. In other words, there is need of standardising the methods applicable to all parts of India for the guidance of soil survey workers. In my opinion an Ad-Hoc Committee of experienced soil scientists of India may be formed to formulate the soil survey technique, nomenclatures, etc. keeping in view the Indian conditions of soil formation.

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5. R. V. TAMHANE (New Delhi) : *Soil Survey, Its Technique and Application.*

In the earlier days of research on soils it was believed by soil chemists and physiologists working on soils in laboratories, green houses and small plots that soil was like a 'money-bank' from which withdrawal of plant nutrients by plants can be replenished by returning to them in equal amounts of manures and fertilizers. This was considered to be the solution of maintaining the fertility of soils, but this is not all, there is a great deal more needed for a clear understanding of soils than just following the principles of give and take. It has been seen that soil differs very much in their character, although developed on the same geological formation under various climatic and biotic conditions.

In the development of agriculture of a region, land must be understood first, its elevation, slope and general configurations may be almost equal important as the soil characteristics.

Soil Survey is the function of soil classifications. Its material comes from observation and experimental method, its working tool is the method of logical scientific correlation. Soil classification depends upon the results from all branches of fundamental and applied soil science. Soil Surveys is an integral part of an effective agricultural research and advisory programme. It is clearly impossible to carry out exhaustive and expensive researches on every kind of field and farm. Representative sample areas of land must be chosen. Standard system of classification is the only reliable basis yet found for selecting such sample area. Every experimental field is a sample of landscape. As the new discoveries are tested the results can be classified by kind of soil and when we know that a certain soil is sandy and the other deep heavy clay the results obtained on heavy soils cannot be safely applied to sandy soils and vice-versa. Here comes the essence of classifying soils into different groups and a basic soil map serves the required information.

If a basic soil map is made accurately then it will serve the purpose of developing the land classification according to irrigability, it will also help to reclaim the land through drainage improvement and it will also serve as a basis for the preparation of land use capability maps in soil conservation projects.

With generalized schematic soil association maps broadly defined agricultural potentialities and problems that relate to the soil or soil use can be seen regionally nationally or even on a world-wide basis of comparison,

### 6. S. K. MUKERJI (Calcutta) : *Soils of Lower Gangetic Alluvium.*

Schematic type of soil survey was adopted to study the soils of lower Gangetic alluvium. Preparation of schematic soil map from spot observations was undertaken. The profiles were studied at 6 mile grid-intersection points. Soil profiles were examined upto a depth of 4 ft.

All such soils associations which have originated from the alluvium laid down by the Ganges and situated in the natural regions, formed as a result of the physical features and water sheds of the River Ganges have been given the family name Ganga alluvium.

The soils of each of these families have been sub-divided into several soil associations. Topography, mode of formation, the design and the development of the profiles are the major considerations in setting up of four profile groups or associations in the family of Ganga Alluvium.

They are :

1. Ganga Riverine lands
2. Ganga Flat lands
3. Ganga uplands
4. Ganga lowlands.

Ganga Riverine has two phases :

(*a*) Inundated phase—Ganga Riverine chars.
(*b*) Highland phase—Ganga Riverine Ridges.

### 7. DR. S. D. NIJHAWAN : *Soil Survey—Its Technique and Classification.*

Soil Survey has, so far as the speaker is aware, been carried out in India on the basis of genetic classification of the soils. Uttar Pradesh is perhaps the first State to introduce a utilitarian classification of soils on a large scale. It has now been widely recognized that this latter type of classification is best adapted for the improvement of agriculture and food and fibre production.

In the Punjab, a similar utilitarian classification of soils has recently been taken up with success. The primary characteristics including effective soil depth, depth of surface soil and soil permeability and secondary soil characteristics including salinity, alkalinity, organic matter, moisture conditions, presence of hardpans and their depth etc., are separately recorded. Associated land features like slope, erosion, wetness, drainage, overflow hazards etc., are also noted. The primary and secondary soil characteristics, along with the associated land features, are delineated on the map by means of symbols. The completed field work alone enables one to divide the surveyed are into well defined units according to their use capabilities.

It is possible for one surveyor to cover an area of about 640 acres (-1 sq. mile) in one day and delineate the different units on a map. This system is likely to save expenditure and time and is therefore recommended for adoption.

Prof P. Gerasimov's lecture on the Soil Map of the Soviet Union was followed by a number of questions centering mainly round the exceptional physical and chemical behaviour of chernozems.

To questions by Dr. S. P. Roychaudhuri Prof. Gerasimov replied by saying that the chernozems are generally formed on limestone, loess and sand, but hardly differ in their productivity. To Dr. R. S. Murthy's query he said that the texture of chernozems varies from clay to sand, those formed on loess being more clayey. Ch.'s are calareous and carbonate content is generally higher at lower depths. In reply to Dr. R. V. Tambane Prof. Gerasimov mentioned that it is not difficult to distinguish the C-horizon or the parent material in Ch's, which are usually deep, but not being acquainted with the deep black soils of India he could not explain why parent materials in them could not be demarcated. The dark colour of Ch., Prof. Gerasimov said in reply to Dr. R. S. Gupta's question, is mainly due to humus, but some humus materials may appear brownish. Prof. Gerasimov said that no satisfactory explanation could be given of the Indian black soils containing less than 0·5% organic matter as Dr. D. K. Patel had reported. The Russian Ch.'s contain about 6% organic matter. In reply to a question by Dr. A. K. Bhattacharya Prof. Geramisov said that humification of raw organic matter is one of the methods used for improving the physical properties of soil particularly in the Podsol soil regions. The northern soil regions, he said in answering Dr. R. P. Agarwal's question, are low in microbiological activity and hence call for biological fertilisers, but he could not mention the actual variety of such fertilisers used. In reply to Dr. B. C. Roy's query he observed that there appears to be no direct relation between the geological and soil maps of the U.S.S.R. but from the genetic point of view some relationships do exist. Prof. Gerasimov said in reply to Dr. Sant Singh's question that no decision had been arrived at even after consultation with Prof. Kubiera regarding the adoption of micropedological studies in connection with soil classification.

## THE SOIL MAP OF THE SOVIET UNION

### (Theoretical and Practical Significance of the New General Soil map of Soviet Union)

ACADEMICIAN P. GERASIMOV:

Soils have been for many centuries a subject of interest to scientists of all lands and nations. This was primarily due to the fact that soil is the chief mean of agricultural production. Learned agriculturists as well as ordinary tillers have always shown concern for finding most efficient methods of plant cultivation on all kinds of soils. The accumulated experience of the people bears out the great variations existing in the natural fertility of different soils. However, the causes of these variations remained unknown for quite a long time, making it impossible to achieve any improvement of this fertility on a genuinely scientific basis. It was the Russian scientist V. V. Dokuchayev (1846-1903) who starting as an ordinary geologist soon became an outstanding geographer and then grew to be an universally-recognized founder of the truly scientific soil science which proved capable of explaining the causes of variations in the major properties of soils and elaborating methods of their improvement.

Dokuchayev's scientific works, at present considered classical, gives a scientific definition of the term "soil" and point out the main properties which distinguish soils from the other nature bodies. Dokuchayev also developed a profound theory explaining the various soil-forming processes and outlined the main laws governing the geographical distribution of soils over the earth. Dokuchayev's theory of soils as of peculiar and independent formations of nature, distinct from the rocks of the earth crust, has by now completely ousted all previously accepted points of view on the soil.

According to the views which prevailed in the first half of the 19th century the soil was just the loose upper layer of a rock or sediment containing decomposing remnants of animals and plants. All the major soil properties were accordingly traced back to the properties of the parent rock. If the surface was formed of solid rocks different in composition it was spoken of as gneiss, or slate, calcareous and other soils and if loose sediments lay on top, then loess, sands, loams, clays and other terms were mentioned. Dark-coloured soils rich in animal and plant remnants were called peats or chernozems, What with all the works written by Dokuchayev and his numerous followers and disciples, most of the terms we have just mentioned have become obsolete and dropped out.

Contemporary soil science rests primarily on the conception that different soils constitute independent natural bodies. Their process of formation differs from that of other natural bodies and this correspondingly calls for specific methods of research. According to Dokuchayev the soils of the earth are formed as a result of "an exceedingly complex interaction of local climatic conditions, fauna and flora, composition and structure of parent rock, relief and also the age of this or that territory" (see V. V. Dokuchayev, "Russian Chernozem," (1883).[1] This general statement which bears the gist of the modern conception of the origin of soils has a profound theoretical and practical meaning. It signifies that the changes produced by biological causes (animals and plants) in the upper layer of rocks result in a singular soil layer forming and developing on the surface of the earth. This layer develops under different climatic and relief conditions and contains many mineral and organic substances absent in the underlying rock. The properties inherent in the soil thus formed can be traced back to these substances and are at the same time a result of various physical, chemical and biological processes going on in the soil layer. All or some of those properties (the principal ones) determine the so-called natural (original) or potential fertility of the soil, which when brought under cultivation and subjected to various agrotechnical methods changes into actual or effective fertility on which the yield of the agricultural crops directly depends.

Thus we see that the main feature of the soils, these independent natural bodies, is their unbreakable and uninterrupted (functional) inter-action with the surrounding natural environment, i.e., with the soil-forming factors.

The changes in these factors (that is, in the climate, vegetation composition of parent rock, and relief) call forth corresponding changes in the composition and properties and also in the essential dynamics of chemical, physical and biological processes taking place in the soils. Because of this remarkable feature of soils they may be called, to quote Dokuchayev, "the converging point or mirror for natural geographic landscapes, and thus soil science itself, more than any other science, is placed in the centre of the whole system of geographical sciences which make a study of our geographical environments in all their entirety and interconnections".

The correctness of this definition is vividly brought to life in the General Soil Map of the Soviet Union presented here. The map, with a scale of 1 :4,000,000 was published in 1954.[2]

This map elaborated by the Soil Institute of the USSR Academy of Sciences composes a part of special set of maps which are used in the USSR higher schools and universities. A document of vast scientific value, this map is used also in training future geographers, soil-workers and agronomists.

Scientific principles and technical methods employed in making soil maps make for the most synthetic content of these maps when compared with all the other types of geographical maps. They are in fact a profound generalization of the whole complex of natural conditions prevailing in this or that territory and determining the formation of various types of soil.

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[1] According to the more precise definition now in use soils are formed out of rock as a result of changes wrought in it by biological factors (animals and plants) under different climatic and relief conditions.

[2] The full title of the map is : "Soil Map of the Soviet Union for Higher Schools" Scale 1 :4,000,000. Compiled by the Scientific Maps Editing Service of the State Department for Geographical Charting and the V. V. Dokuchayev Soil Institute of the USSR Academy of Science in 1954. Author's copy, drawn by N. N. Rozov in collaboration with E. V. Lobova (contributed on the desert zone), it based on the materials collected by the Soil Institute of the USSR Academy of Sciences. Chief Scientific Editor, Academician I. P. Gerasimov, Editor, I. A. Balantseva.

As is for India the scientific and practical worth of soil maps is of special significance for the Soviet Union—a country of vast territories and extremely varied climatic conditions and soils.

Wide use is made of soil maps. Thus, for instance, soil maps are used for general evaluation of land resources in accordance with their grade and for a due distribution of various agricultural and irrigation projects. They are used also for agricultural purposes to have this or that idea divided into districts. At the same time soil maps help in solving a number of theoretical questions (for example they help to establish the only correct system of classification of soils).

The General Soil Map of the Soviet Union has 63 symbols for different genetic soil subdivisions and 9 symbols for the texture of soils and parent rocks. Due to the fact that 9 symbols are additional and may combine with various genetic soil subdivisions the total number of symbols used and their combinations adds up to many hundreds. Notwithstanding the great number and variety of these symbols the new soil map of the Soviet Union does not lose in appearance. Rigid principles in the selection of the most typical genetic subdivisions which are based on the scientific systematization of soils and a chart of colours and symbols especially arranged for this occasion make it possible to illustrate on the map both major geographical and genetical relationships of the soil cover of the USSR and various concrete details of great importance.

Let's look at this map. First of all we can vividly see that the whole territory of the Soviet Union is divided into three huge latitudinal geographical belts—the Arctic (polar) tundra belt in the north (in grey and steel-grey). The Boreal or humid (the northern part of the moderate latitude belt) belt of taiga with forests and bogs in its centre (in red and pink). The Arid belt (the southern part of the moderate latitude belt)—a belt of steppes with deserts in the southern part (in brown and yellow). This last belt stretches in the western part of the USSR up to the Altai Mountains and further is represented by isolated areas (in mountain ravines) east of the Altai Mountains.

Primitive crypto-gleyey and gleyey soils of arctic deserts and tundra prevail in the Arctic (polar) belt. The boreal (humid) belt mainly abounds in different sub-types of podzolic soils (gleyey-podzolic, typical podzolic, sod-podzolic, and others) and also in peaty and podzolic-peaty soils characteristic for some types of forests (including swampy forests) and bogs.

The soil crust is especially varied in the arid belt; here we have some forest soils (grey and brown-podzolized forest soils) which go together with the southern broad-leaved woods, chernozem and chestnut soils of the steppes, various desert and semi-desert soils (brown, grey-brown, serozems and others) and small and big areas taken up by solonetz and solonchaks.

Still another important geographical belt which occupies much less space on the soil map of the Soviet Union is the Subtropical belt. On the territory of the Soviet Union there are just two not very extensive areas (characterised by excessive rainfall): Kolkhida in the Western and Lenkoran in the Eastern Transcaucasia. The geographical peculiarity of these regions is due to their location in the south, the proximity of the sea coast and the existence of a bulwark against the cold northern air masses—the Great Caucasian Range. The southern Crimean coast, Central Transcaucasia and certain southern regions in Central Asia are characterised by more continental and dry subtropical climates (of the Mediterranean type). All these relatively small areas abound in peculiar sub-tropical soil types—yellow, red and brown.

The most general and universal law of geographical distribution of natural landscapes on the earth's surface—the latitudinal bio-climatic belt and zonal distribution—has been actually given a much more profound interpretation on the General Soil Map of the Soviet Union than outlined before.

This law makes itself felt very forcefully whenever the local conditions allow it, that is, on vast continental plains. It manifests itself in a kind of huge zonal spectrum representing an intricate system consisting of a great number of separate zones, sub-zones and zonal belts—subdivisions of this of that geographical belt. Precisely such a geographical picture can be observed in the whole western part of the Soviet Union plains in the European part of it (the Russian Plain), Western Siberia, Kazakhstan and Central Asia.

The boreal humid belt divides this territory into three big zones—the northern, central and southern taiga. Apart from this there is a belt of mixed broad-leaved woods to the south. All these zones and their boundaries can be easily traced on the Soil Map of the Soviet Union. It suffices to follow for this purpose the geographical distribution of the main subtypes of the podzolic soils (gleyey-podzolic in the northern taiga, typical podzolic in the central and sod-podzolic soils in the southern taiga).

The arid belt in the Soviet Union presents an even more complex zonal spectrum. It begins in the north with a zone of forest-steppes to be replaced further to the south by the steppe zone and by the zones of semi-deserts and deserts. Many of these zones divide into sub-zones. All this can be vividly seen on the General Soil Map of the Soviet Union if the following geographical definition of soils is used in surveying the map.

(a) gray-forest soils, podzolised and leached chernozems—*forest-steppe;*

(b) typical chernozems (very deep and these with a high humus content)—*meadow steppe;*

(c) ordinary chernozems—*typical steppe;*

(d) southern chernozems and dark chestnut soils—*dry steppe;*

(e) light-chestnut soils—*desert steppe;*

(f) brown semi-desert soils—*semi-desert;*

(g) gray-brown desert and takyr soils—*northern desert;*

(h) serozems—*southern desert.*

The latitudinal bio-climatic zones are supplemented in many mountainous regions of the Soviet Union by a well-developed system of vertical climatic belts. This system is relatively simple in structure in the humid (boreal) belt and more complex in the southern arid belt.

Apart from the mountain-taiga podzolic and other soils, which are widespread in the boreal humid belt—the North and Middle Urals mountains, South and East Siberia and the northern part of the Soviet Far-East—we observe there also vast territories under the mauntain-tundra (regosols) soils, covering the barren mountain summits.

A greater variety in the composition and the structure of the vertical soil belts is found in the arid (the steppe and desert) belt, in the Carpathian mountains and in the mountainous part of the Crimea, in the Caucasus and in the Central Asia mountains. Here the place of the mountain-desert (serozems) and the mountain-steppe belts (the mountain chernozems and the chestnut soils) is taken by the mountain-forest belts (mainly the brown-forest soils) while at still higher altitudes we find the mountain meadow and the meadow-steppe belts with corresponding soils.

However, all these remarkable geographical regularities in the zonal distribution are very unevenly expressed throughout the territory of the USSR. In many areas they are altered under the influence of other than the zonal forces of nature, or are obscured by them. But even these alterations, unexpected as they seem at first sight—alterations in the simple and clear zonal regularities—have their own logic, their own foundation.

For instance, the sod-podzolic soils, characheristic of the southernmost part of the boreal (taiga) zone are quite unexpectedly found to have an abnormality broad expansion, as compared with other territories, in the northwest of the Soviet Union. The cause for this geographical anomaly is explained quite easily.

It is precisely here that the Atlantic influence penetrates deepest of all into the continent and softens the severe continental landscapes of the northern areas of the USSR.

A similar case may be observed in the southwest of the European part of the Soviet Union. The influence of the Mediterranean climate is particularly noticeable in the territories bordering on the Black Sea, resulting also in softening climatic conditions in South Ukraine and the western part of the pre-Caucasian plain. The latter includes a vast territory consisting of peculiar Azov Sea (calcareous) chernozems which abruptly change into soils of complex desert-steppes and semi-deserts as we come to the Caspian sea lowland further east.

It is not without interest to note that, though remotely, the Medierranean influence is felt in Central Asia too. Here, all the westward mountain slopes are marked by the presence of peculiar brown soils, common in the countries of the Mediterranean basin.

Speaking of the local or provincial peculiarities as regards the geographical distribution of the soils in the Soviet Union, we must stress the significance of the super-continentality of the entire eastern part of the USSR, particularly of the inner Central Asian mountains, as well as south and east Siberia. Thus, extremely peculiar soils of the high altitude cold deserts (syrts) are developed in Central Asian mountains—in the Pamir and in the Inner Tien-Shan. There is every ground to believe these areas to be small analogues of the Tibet.

On the other hand, in the very centre of eastern Siberia, in an exceedingly severe climatic environment characterised by eternally frozen ground, the soil map shows a sudden appearance in the vast areas of mountain taiga of peculiar sod-forest soils in a combination with the meadow-chernozemic (steppe) soils and solonetz. Hence, we meet here a remarkable geographical paradox—an obvious breach of every law of zonal distribution, an utterly unique combination of the taiga and the steppe elements. But on second thought, we find that under the circumstances there is nothing abnormal in this combination. It is precisely at this place that the world pole of coldness is located which determines not only the coldest climate but a very dry climate too.

As to the Far Eastern Maritime Territory of the USSR the Soil Map of the Soviet Union reveals quite a different local tendency. Under the soft influence of humid monsoons of the Pacific, the severe taiga and mountain-taiga landscapes with the podzolic soils characteristic of Eastern Siberia disappear in Kamchatka. Peculiar soddy soils of grassy sparse forests are found here, and further south we discover typical forest soils of the arid belt—the brown forest soils.

Thus it follows from the above-said that the actual regularities in the geographical distribution of soils and natural landscapes, as reflected in the General Soil Map of the USSR, have developed as a result of a complicated combined influence of the latitudinal bio-climatic zonality, of the vertical belt orography and of local (provincial) climatic influences—continental or oceanic—conflicting with the factors of zonal influence.

It is precisely because of the complicated interaction of such geographical regularities that the natural peculiarities of soils in the USSR are being formed.

The abovesaid may be also illustrated with the aid of certain data. The data are given below and serve to show the general distribution of the soil riches of the Soviet Union. Here they are; the entire area of the Soviet Union is 22,298 thousand sq. km., of which flatlands occupy 15,049 thousand sq. km. or 67·5% of the entire territory of the country. The mountainous regions occupy 6,751 thousand sq. km., or 30·3%. Therefore we may say that only two-thirds of the Soviet

Union are under the flatlands and approximately one-third of its territory is occupied by the mountains.

Further on, the tundra soils account for 1,688 thousand sq. km. of the territory of the Soviet Union (7·6%); the podzolic and boggy soils of the lowlands occupy 6,998 thousand sq. km. (31·4%); the soil of the steppes (grey forest, chernozems and chestnut soils)—3,828 thousand sq. km. (17·2%); the desert and semi-desert soils—2,009 thousand sq. km. (9·4%). Thus it follows that approximately 50% of the entire territory of flatlands in the Soviet Union are covered by forest (taiga) and boggy soils; close to one-third of the territory is under steppe soils, while the remaining part is covered by the desert and other soils. Such a correlation of natural soil types in the territory of the Soviet Union is sufficiently beneficial for an all-around development of agriculture, cattle and poultry breeding and forestry.

A greater part of the mountain territory of the Soviet Union (20·3% of the entire territory of the country) is occupied by mountain forest soils; then come the barren mountain tundra soils (6·5%) and the rich mountain meadows (1·1%) and the steppes (1·8%). Such great diversity in mountain climates helps considerably in the utilisation of the mountain soils for agricultural and other uses.

A chart showing the distribution of cultivated lands throughout the territory of the Soviet Union is placed in the lower corner of the General Soil Map of the USSR. This chart shows the distribution for 1954 without taking into account the developed virgin and long-fallow lands. By comparing this chart with the General Map we see that the principal agricultural areas in the Soviet Union (ploughed lands averaging from 30% to 60% and above 60% of the entire territory) are situated on the chernozems, grey forest, sud-podzolic, chestnut and some other types of soils. The serozems, the meadow-serozemic soils, and the takyr soils are used for irrigation agriculture, while the red, the yellow soils and, to a certain extent, the brown forest and brown soils are used for subtropical cultivation. However, within the range of spot and picked land agriculture, many other soils shown on the map are being cultivated.

We can therefore say that the agriculture of our country makes use of extremely diverse genetical types of soils which differ chemically, physically and biologically. It is clear that owing to the above-mentioned reasons, these soils necessitate different modes of cultivation in order to acquire greater fertility.

The age-old experience of the people has long ago determined the best agricultural methods for these or other soils. A peasant first tilled such soils which were most suitably located and were distinguished by a relatively high natural fertility. Later on agronomy and the soil science have come to help the tillers.

Summing up the experience of the people and elaborating their experience by a scientific research into the properties of soils and cultivated plants and also by a tremendous scope of experimental work, the agronomy has evolved by means of the utilisation of the achievements of soil science a great many methods for the most rational exploitation of different soils and for transformation of their properties to serve the needs of agriculture. Thereby, the methods of cultivating soils with most varied structure and composition were extended and facilitated.

The briefness of this report deprives us of the possibility to describe all modern agronomical methods used for cultivating soils in the USSR. However, we can point out certain geographical principles that are employed in planning melioration undertakings conducted in the USSR. The purpose of these undertakings is to make the best use of different soils. The information gained from the analysis of the General Soil Map of the USSR is widely used in planning these undertakings.

As is commonly known everywhere the tiller who wishes to increase the stock of nutritious elements in the soil introduces additional mineral and organic fertiliser. This is necessary for all intensively cultivated soils. In this respect even the richest soils—the natural soils in the Soviet Union, such as the chernozems, or the grey forest soils—give greater yields with the addition of fertiliser. Such a practice acquires a particular significance in the Soviet Union for the podzolic soils widely distributed in boreal (humid) belt. In addition to mineral fertilisers it is highly important in the case of the podzolic soils to increase the stock of organic matter (by introducing organic fertilisers). Fertilisers produce good results also in various desert and semi-desert soils where they are cultivated with the aid of irrigation.

In the Soviet Union great importance is attached to the melioration of soils, which is necessary for the improvement of the water regime of the soils. In the northern areas in the so-called non-chernozemic belt (the boreal or humid belt) melioration undertakings consist mainly in various kinds of reclamation work intended to increase drainage and to remove excess water from boggy and podzolic boggy soils.

As for the southern areas of the USSR—for the forest-steppe, the steppe and the desert belt (i.e., for the arid belt)—the main melioration work is that of the irrigation type the purpose of which is to increase the moisture content in the soils. Besides the artificial snow retention measures and the blocking of the surface drainage, these measures include also artificial irrigation of various soils. Such measures are necessary for certain chernozems, chestnut soils, brown desert steppe soils, serozems and some desert soils.

Physical melioration measures meant to improve the physical properties of various soils by changing their mechanical content constitute another group of melioration undertakings conducted in the USSR. These measures include for example the removal of boulder and pebble material from the soils.

The next group of extremely important and radical soil melioration improvements in the USSR is made up by the chemical melioration measures, such as liming, gypsing and the introduction of various micro-elementes (copper, boron, etc.). The podzolic, the red and the yellow soils, more than any other soils, need the introduction of calcium to neutralise the acid reaction, and to improve their physical properties. The solonetz and the highly alcaline soils are in need of introduction of gypsum artificially or its substitutes. Finally, the secondary-salinized soils which are formed within the areas of irrigated agriculture, need periodic leachings to remove the surplus of water-soluble salts.

Biological melioration (bacteriological fertiliser) are particularly important for some northern soils. These measures are meant to activise the microbiological activity within these soils.

Thermal melioration measures to improve the temperature regimen of the soils are also important for the above mentioned types. One of the widely-used methods for thermal melioration is the mulching of soils.

The anti-erosion measures are also of particular importance. These are applied to do away with or to prevent the erosion of the soils as well as to protect soils from winds in many areas having a dissected relief or affected by strong winds. The anti-erosion measures are being taken for most different soils, subject to washing away or windblowing.

Measures for elimination of secondary salination are of special importance in the areas of irrigated agriculture. These include strict allowances of irrigating water, diminishing of filtration of the irrigation water supplied from canals, leaching of salinized soils, and the drainage of the territory to remove excess waters, and bringing down the ground water level. These measures are being conducted in many lowland areas of irrigated agriculture within the desert zone of the USSR, i.e., serozem soils, meadow-serozemic soils and the takyr soils.

All this goes to prove that with the aid of the soil map a geographical scheme for the use of various agricultural and reclamation measures can be worked out to improve the soils properties and increase their fertility.

This problem can be easily solved with the help of the General Soil Map for the whole area of the Soviet Union. However, due to the small scale of the map, such scheme in this case can be only of a general character. The more detailed maps, intended for use on the soils of individual regions, provinces, districts and even individual collective farms, can be worked out on the basis of the bigger scale soil maps. That is why the land survey departments in the Soviet Union had been busy for years in composing a large set of soil maps—beginning with soil maps of individual collective farms, or state farms (scale 1 : 10,000—1 :50,000) and ending with maps of administrative regions (1 :100,000—1 :200,000). The General Soil Map of the USSR, which is hundreds and thousands of times less detailed than the maps composed for individual farms or administrative divisions, however, represents a scientific compilation of many thousands of detailed soil maps.

Thus it represents a product of cartographical generalisation which is based on scientific cartographical principles and contemporary genetic soil science.

## II. EFFECT OF DIFFERENT CROPPING SYSTEMS ON THE STRUCTURAL CONDITIONS OF SOIL

8. S. D. NIJHAWAN :

The importance of soil structure in affecting the productivity of soils has not been realised to the extent that it deserves. In the past much stress has been laid on soil nutrients, but the effect of physical make up and arrangement of soil particles on soil fertility has not been fully appreciated. It has led to certain wrong notions. For instance in 1939 the author in the Punjab observed that wilting of gram was wrongly attributed to the attack of certain fungi but was mainly due to the occurrence of hard pan in the sub-soil. The failure to correctly appreciate the role of soil structure is partly due to the fact that no reliable method is available for evaluating the soil structure. Generally Yoder's technique for the determination of water stable aggregates, an attribute of soil structure, is employed but the author observed that this also fails to give true picture about the water stable aggregates and thus the soil structure. However rate of percolation of water in soil cores obtained in situ seems to give reliable information about the nature of soil structure but it has also its limitations.

Soil structure is greatly affected by the cultural practices and cropping systems. At Hay's Experimental Station the author observed that the plots which remained continuously under maize had less amount of water stable aggregates than the plots under wheat. It shows the effect of fibrous root system in improving structure. Similar investigations carried out in the Punjab show that growing of berseem at Ambala and Rohtak greatly improved the structure, which was indicated by improved rate of percolation of water. At Gurdaspur also introduction of legumes in the rotation improved the permeability of the soil. A similar soil continuously under wheat was found to be much less permeable than the one having legumes in the rotation. Growing of lucerne at Sirsa was also found to improve the rate of percolation of water.

It has been further observed that soil crumbs with the size between 3 mm. and 0·5 mm. control the crop yields. This amount is greatly controlled by the cultural practices.

9. R. V. TANHANE (New Delhi) : *Effect of Different Cropping Systems on the Structural Condition of Soil.*

It is recognised that the productivity of a soil depends to a large extent on good soil structure and its nutrient status. Although fertilizers supplement the natural fertility of our soils, Soil scientists have shown that not all types of fertilizers help to promote the soil *structure* and maintain it. A poor soil structure means poor crop yields.

A good soil tilth maintains a good balance of air-water supply suitable to the plants growth. The basic research has shown what happens to soil when structure is improved as regards the properties of soil.

Unfortunately the evaluation of structure is rendered difficult since it is the result of many variable forces. Methods of structural characterisation include study of permeability, porosity and direct determination of the particle size distribution. The formation of structure has been explained on a dipolecation-dipole link by E. W. Russell.

Natural factors like alternate drying and wetting and the cultural practices at optimum moisture content are accepted principles for preventing structural deterioration.

The effect of various cropping system on soil aggregates has been studied by many investigations and their result point out that the most effective way for regeneration of good soil structure is the combination of deep-rooted legumes and a grass or good by farming. Continuous row cropping hasten the destruction of soil organic matter and of soil tilth. Similarly, the organic matter serving as a granulating agent in soil has long been recognized. The prospect of microbial synthesis and the role of micro-organisms as indirect agent in the decorposition of fresh organic material has been found to be more useful than compost when incorporated with soil.

Recent investigations have brought out that naturally occurring polyuronic acid salts and other chemicaly related polysaccharides contained in organic matter have better quality of improving soil structure. The role of these natural gums in binding soil particles is made use of by commercial firms in producing chemicals known as 'soil conditioners'.

Soil structure, however, has a predominating influence on seedling emergence and plant growth. A desirable soil structure may be prepared prior to seedling but it breaks down during the growth of a crop, but the inherent character of a soil to possess and maintain desired soil structure is of primary importance in study of soil structure.

## Effect of Different Cropping System on the Structural Conditions of Soil

*Chairman*: DR. S. P. RAYCHAUDHURI

The following participated in the discussion and made their observations as follows:

*Dr. D. K. Patel*: At the Sugarcane Research Station, Padegaon, it has been observed that no single method correctly evaluates soil structure, but a clearer picture is obtained only by correlating the results of several methods, such as: (*i*) determination of humus content, (*ii*) water-stable aggregates, (*iii*) pF curve, and (*iv*) permeability studies in the laboratory and in the field.

*Dr. K. C. Tejwani*: The beneficial effect of legumes is not due to improvement of soil structure alone, as Dr. Nijhawan puts it, but to a simultaneous improvement of the physical, chemical and biological properties of the soil. For instance, in the Punjab, the beneficial effect of legumes in the irrigated soils is perhaps due to an increase in the water holding capacity, a contention which can be verified by actual measurement.

*Shri S. C. Mandal*: Dub grass when grown after a dressing of ammonium sulphate brings about considerable soil aggregation only after seven or eight months of culture. Very short-duration leys can, however, be worked out in our country for improving soil structure.

*Dr. S. V. Desai*: While studying the effect of cations on soil structure, that of the anions, e.g., $Cl^-$, $SO_4^=$ and $PO_4$ present in soil solution should not be lost sight of. Soil aggregation is caused by humus and other binding materials, of which the mucilage produced by the decomposition of organic matter and micro-organisms plays no mean part.

*Shri Bishan Mansingh*: In order to improve soil structure by dub grass it is recommended that the latter should be grown from June 15th to October 15th after a dressing of ammonium sulphate, and that the ploughing of the field should be started during the same period. Ploughing which primarily improves soil structure may therefore be done away with, if dub culture is practised.

On the various points raised during the discussion Dr. S. D. Nijhawan made the following observations: (1) The legumes having a narrow N:C ratio are easily decomposed by micro-organisms and are converted into materials which are capable of forming aggregates with the soil particles. (2) The value of the non-capillary pore-space, which should preferably be about 50%, has been worked out for optimum growth of different crops e.g. about 40% for cotton and as low as 10% for cereals. (3) The effectiveness of different crops in building up soil structure is determined by their root systems. Those of grasses are followed by legumes in order of effectiveness, while the cereals are least effective. (4) The modification introduced by him in Yoder's method of determining soil aggregates consists in allowing suction or placing the sieve with the soil sample on wet sand. These procedures enable entrapped air to escape, otherwise aggregates do not easily wet.

In reply to Dr. K. L. Nayar, Dr. R. V. Tamhane explained that the non-capillary porosity of a soil is obtained as the difference between its maximum water holding capacity and its moisture equivalent.

## III. THE USE OF ORGANIC INSECTICIDES IN THE CONTROL OF INSECT PESTS OF AGRICULTURAL CROPS

1. B. H. IYER and M. L. MURTY (Bangalore): *Chromatographic Isolation and attempts towards synthesis of sesamin.*

Sesamin, sesamol and sesamolin are the three minor constituents of sesame (*Sesamum indicum*, Linn) oil. Eagleson (*U. S. Patent* 2,202,145 of May 28, 1940; *Soap and sanit. chemicals*, 1942, *18*, [12], 125) has patented the application of sesame oil as a synergist or activator for pyrethrins, rotenone and allied insectisides. Haller *et al.* (*J. Org. Chem.*, 1942, *7*, 183; *J. Econ. Entomology*, 1942, *35*, 247) have shown that sesamin and sesamin-rich fractions of sesame oil have the maximum synergistic action on pyrethrin insecticides. Beroza (*J. Am. Oil Chemists' Soc.*, 1954, *31*, 302) has shown that sesamolin is five times as synergistic as sesamin, even though the former is usually present in the oil in smaller amount than sesamin.

Tocher (*Pharm. J. Transac.*, 1891, *51*, 639 and 1893, *53*, 700) isolated sesamin from sesame oil by extraction with cold acetic acid. Villavecchia and Fabris (*J. Soc. Chem. Ind.*, 1894, *13*, 69) isolated it from the unsaponifiable portion of the oil. Iyer and Murty (*The Oils and Oilseeds J.*, Symposium Number, 1953, *5*, 100) isolated sesamin from a bazaar (Bangalore) sample of expressed oil and also from a solvent (carbontetrachloride) extracted sample, employing Tocher's (*loc. cit*) method. The average yield of sesamin from both the samples has been 0·2 per cent on the weight of the soil. Extraction of the oil with warm acetic acid or with cold ethyl alcohol gave only very poor yields. By chromatographic adsorption method using an alumina column 0·25 g. of sesamin has been isolated from 100 g. of the oil.

Sesamin has been shown to enhance the carcinogenic effectiveness of benzopyrene dissolved in sesame oil (*cf. Chemical Abstracts*, 1950, 44, 118h). Although sesamin indicated *in vitro* tuberculostatic activity (*Current Science*, 1952, *21*, 246; *J. Indian Inst. Sci.*, 1953, *35*, 69], it could not give any significant protection against $H_{37}R$ strain when tested *in vivo*.

In an attempt to synthesise sesamin, model experiments were first carried out with dethyl benzoyl succinate obtained by dimerizing ethyl benzoyl acetate. The former has been reduced with $LiAlH_4$ to get the tetrahydroxy compound which on cyclization with polyphosphoric acid (PPA) has given the benzene analogue of the skeletal structure of sesamin.

Similar series of reactions were then conducted with diethyl dipoperonyl succinate. From the elemental analysis and the ultraviolet adsorption data, it has been surmised that the two compounds (m.p. 119° and m.p. 195°) isolated in this case are possibly two isomers of sesamin.

## The use of Organic Insecticides in the Control of Insect Pests of Agricultural Crops.

2. DR. A. P. KAPUR (Calcutta) : *Use of organic Insectides in the control of insect pests of agricultural crops.*

The widespread use of modern organic insecticides in the world is giving rise to new problems in entomology. In India, although the acreage under crops that are being sprayed is not relatively high, there are indications of spraying becoming more widespread in the near future and it is time that we in this country take stock of the general problems arising from the use of insecticides. Leaving aside the largely undecided question of resistant strains of insects, there is no doubt that natural insect enemies of major pests as well as of other insects which are not so destructive, are also killed by these insecticides. This results sometimes in severe outbreaks of pests like certain mealy bugs, e.g., *Phenococcus insolitus*, on brinjals. Sometimes pests which were hitherto considered to be of minor importance become pests of major importance and indeed begin to spread in other localities where they were previously of no consequence. Either because their insect parasites and predators are killed by powerful insecticides or for some other little understood reason, their population increases. Such a situation seems to have arise in Ceylon in respect of the Pentatomid bug, *Scutinophora lurida*, on paddy. In West Bengal also, in fields which were being treated previously with BHC against the paddy swarming caterpillars and rice Hispa (*Hispa armigera*), a bug (*Sogata* sp.) was reported to have appeared in large numbers for the first time in that State. In literature 3 spp. of *Sogata* were recorded on paddy by Fletcher (1917) as far back in 1917 in Bihar, but these were never considered to be serious because of the small numbers in which they occurred. In India this aspect of control by insecticides require more attention. It was suggested that while the work on insecticides, both in respects of pests and other insects is extremely important and useful, the main objective of controlling the pests by more subtle methods of biology, such as ecological and biological means of control, should receive equal if not more consideration.

3. S. PRADHAN (New Delhi) : *Use onf Organic Insecticides in the Control of Insect Pests of Agricultural Crops.*

In order to develop efficient use of insecticides for the optimum control of insect pests we at the Indian Agricultural Research Institute, New Delhi have been working on a number of factors on which the success of chemical control operation depends.

I. *Ecological factors* :

The one aspect which has particular importance under Indian conditions is the effect of ecological factors like temperature and humility on the toxicological response, i.e., susceptibility of insects.

(a) *Temperature* :—It has been demonstrated that temperature has to be differentiated into three separate components : (a) temperature during treatment which increases the uptake of the insecticide, (b) the temperature of after the treatment which increases upto a certain degree the physiological resistance of the insect to the insectide and (c) temperature before treatment which increases both physiological resistance and uptake of insecticides. It has been further shown in some cases that the change in insects' resistance to insecticides with change in temperature follows essentially the same curve as is obtained in the case of temperature effect on any other physiological activity.

(b) *Humidity* :—It has been shown to have often very profound effect on insect kill but the exact nature of the effect differs from insect to insect with the same insecticide and from insecticide to insecticide in the case of the same insect.

II. *Effect of particle size* :

The conflicting observations of ours and of various previous workers have been analysed and explained on the basis of the hypothesis that the toxicity of insecticide particle is governed mainly by two factors viz. (a) the area of contact between the insect body and insecticide particle, this being more in the case of smaller particles and (b) the retention of insecticide particle which is more in the case of bigger particles upto a certain size.

III. *Solubility of insecticides in cuticular waxes* :

The contact insecticide has to penetrate the insect body wall before producing its effect. We have developed a very useful technique of studying the solubility of insecticide particles in the wax covering of the insect body surface and shown in a few cases so far that if other factors do not interfere those insects are more susceptible in the cuticular waxes of which the insecticide dissolves more readily.

IV. *External and internal resistance* :

It has been demonstrated in the case of fumigation with HCN that insect mortality depends both on external resistance to the entry of the fumigant as well as on insects' internal resistance and that these two components of resistance differ markedly in different insects.

V. *Causes of difference in resistance of different instars of locust* :

Out of about a dozen factors studied so far, three viz. (*a*) surface area per unit body weight, (*b*) percentage of wax in the exuviae, and (*c*) thickness or compactness of the exuviae show significant correlation with resistance of different instars.

VI. *Persistence of insecticides under field conditions* :

These studies have been carried out so far in the case of cotton, sugarcane and castor crops.

*VII. Bioassay of insecticides* :

Last but not the least is a continuous project under which the relative toxicity of various new insecticides is being determined in the case of all important pests taken one by one.

Some work is also in progress on the effect of insecticidal treatment on the viability of seed grains.

4. N. BHOJRAJ NAIDU, M. B. NAIDU, (MRS.) OSMANI, BHARAT BHUSAN and S. H. ZAHEER (Hyderabad-Dn.) : *Some Insecticides from Vegetable Oils and Turpentine.*

Hyderabad has an estimated production of 15,000 tons of *Annona squamosa* (*Silaphal*) seed, in addition to large quantities of *Pongamia glabra* (*Karanja*) available in South East of Mahaboobnagar District, possessing insecticidal activity. Our present work (*J. Ind. Chem. Soc. Ind. and News Ed.* 1953, *16*, 173) reported the variation in the insecticidal activity of *A. squamosa* seed oil obtained by different methods of extraction of the fat; while in the present work the separation of toxic principle or principles associated with its purification, has been attempted. The insecticidal potent principle of Annona Seed examined in a variety of media, has been shown to be highly toxic to pumpkin beetles, cabbage aphids and house flies, however the action is of relayed type. Various attempts have been made to isolate the toxic principle from the seed, oil, etc. by different solvent fractionation techniques, and ultimately obtained a product, which is likely to be purer than the product isolated by Harper *et al.* (*Ann. Applied Biology*, 1947, *34*, 104), and characterized by its chemical and physiological activity. Alkali treatment has resulted in the destruction of the toxic material.

The alcoholic extraction of the Karanja seed oil in 4% concentration in acetone has been found to be highly toxic to house flies using both topical method of application and spraying; while it has been found to be quite ineffective against stored grain pests, showing thereby the insecticidal activity of the oil is of restricted nature.

Chlorinated Indian turpentine having a chlorine content of 60·7% has been found to be highly toxic to house-flies, cock-croaches, mosquito larvae, and compares favourably with DDT. It is also farily toxic but it is less toxic than toxaphene (Cl-67-69%) to R. Castaneum beetles and adults. From the available data it appears to belong to the toxaphene-type of insecticides.

5. DR. I. M. PURI : *Some Insecticides from Vegetable Oils and Turpentine.*

Will Mr. Naidu tell us about the vehicle used for spraying this insecticide extracted from Shoanfa seed?

There is no doubt that search for indigenous products as insecticides should be continued as even if they are more expensive they are at least produced in the country. A standard technique for comparative studies should always be followed and LD50 should be studied in every case.

Cost of new insecticide of vegetable origin need not be considered in this case and has to be taken into consideration of and when the efficacy of the new insecticide has been proved.

6. DR. K. K. NIRULA (Kalyangulam) :

Dr. Pradhan had mentioned that the spraying of the insecticides should be preferably carried on in the evening, so that the lower temperatures prevalent at night, would be more suitable for killing the insect. I pointed out that from our practical experience of spraying the coconut palms for the control of the coconut caterpillar *Nephantis Serinopa* with 0·2% DDT, it was found out that spraying was more effective, if carried out in the forenoon during the bright sunshine. If by some chance the spraying was carried out in the evening, it had to be repeated, as its toxicity was found to wane within a week or so.

I further brought to the attention of the audience, the possible accumulations of harmful residues of insecticides in soils. Evidence proves that many of the newer insecticides persist in soil for more than five years. Often a given piece of land may be treated safely with a certain insecticide as far as one crop is concerned, but it may be extremely harmful to others. Application of 5% BHC dust for the control of cockchafer grubs in the coconut gardens on the West Coast, was found to give good control of the pest, but this insecticide proved extremely harmful to the intercrops like tapioca, yam etc. commonly grown in the cocoanut gardens. Similarly BHC treated organic manures at high doses are also found to impart bad taste and foul smell to some of the root crops, to which this insecticide is applied.

The effect of the organic insecticides on the beneficial parasite, was also brought to the notice of the worthy speaker. Under the general field conditions prevalent on the West Coast of India, it was found that 0·2% DDT which is advocated for the control of *Nephantis Serinopa* remains highly toxic to the Euloplid parasite *Trichospilus pupivora* for a period of upto two months.

It was suggested that all these factors may be kept in view, while formulating the new insecticides.

7. HEM SING PRUTHI : *Organic Insecticides.*

Since in practice, the temperature cannot be varied before, during and after spraying or dusting in the Ent. Labs. of the Punjab University, the effect of temperature on the action of BHC at uniform countries throughout. The effect of BHC increases with temperature.

The effect of humidity should not be uniform with spraying experiments.

The effect of fumigants in the afternoon is increased not so much due to the changes in insect actually but due to the increase in volatility of fumigants.

8. H. ZAHED :

Standard methods (entomological) for testing insecticidal activity have been used and activity as compared to standard types of known insecticides have been studied and determined. Tests have been carried out (Laboratory & Field) in my laboratories as well as outside and compared mainly with D.D.T. Work has been concentrated mainly on the oil itself.

9. N. BHOJRAJ NAIDU : *Some Insecticides from Vegetable Oils.*

If the unsaponifiable matter was active?

(1) What is the yield?
(2) Did you try the lower doses?
(3) What is the cost of oil?

Still the work is at experimental stage. More work will have to be done till the oil can be used as insecticide more effectively and economically.

10. M. B. NAIDU (Hyderabad) : *Physiological Action of Organic Insecticides.*

Much work has appeared on organic insecticides concerning their toxicity and effect on insects of agricultural importance,—but comparatively little attention has been paid towards their physiological action and particularly their mode and site of action.

The physiological action of natural pyrethrum and allethrin (synthetic pyrethrum) has been studied on the isolated heart of cockroach. It is shown that natural pyrethrum after nicotine treatment which specifically acts on the cardiac ganglia does still produce a further effect on the insect heart by virtue of its additional activity on the neuro-muscular system. But this does not happen with nicotine treatment preceeded by the administration of pyrethrum.

Allethrin unlike pyrethrum acts primarly on the cardiac ganglia and not on the neuro-muscular junction. After nicotine treatment allethrin does not produce any further effect on the heart of cockroach, it is also true if the treatment is reversed. It is suggested that the restricted action of allethrin may be the cause for its inferior toxicity towards certain insects in comparison to that of pyrethrum.

The actions of pyrethrum and allethrin are shown to be due to the release of acetylcholine and not due to the inhibition of cholinesterase as is found in the case of organo-phosphorous compounds.

11. P. M. VARMA (Poona).

(1) Asked whether these studies have any bearing on the control of insects in the field. The work of spraying has to be started in the morning and finished in the evening. The temperature cannot be controlled. The condition in irrigated crops (rice-sugarcane) will be absolutely different. Particle size cannot be controlled.

(2) Asked at what stage of the *Earia* sp. the tests were carried out?

## ENERGY METABOLISM

### Section of Physiology

1. S. BANERJEE (Calcutta): *Symposium on Energy Metabolism.*

*Surface area of the body of Indians*: The metabolic rate is expressed in terms of calories per square meter of the body surface. Whatever may be the theoretical significance of the body surface as a biometic unit for the reference of metabolic rate measurements, it seems at present that the use of such a unit gives the least variable results for individuals differing in size. The surface area of the whole body is universally calculated from a formula suggested by Du Bois and Du Bois based on weight and height of the person: $A = W^{0.425} \times H^{0.725} \times 71{\cdot}84$ where A is the surface area in $cm^2$, W is the weight in kg, H is the height in cm and 71·84 is a constant. For any work on energy metabolism it is, therefore, desirable to find out if the surface area of the body as determined by the above equation is correct in case of Indians because workers in Japan and China have shown that the above equation of Du Bois and Du Bois is not applicable in persons of those countries. We have, therefore, determined the body surface area by actual measurements in order to find out if the surface area of the body calculated from the above equation differs from the surface area of the body actually measured.

Fifteen male subjects consisting of students, research workers and members of the teaching stuff of the department of physiology of the Presidency College, Calcutta were selected and the surface area of the body of each individual was measured by using diverse methods.

The surface area of the body of each individual was also calculated from the weight height equation of Du Bois and Du Bois and the results were compared with the surface area of the body actually measured. It was observed that the surface area of the body actually measured was more than the area calculated with the equation of Du Bois and Du bois in all the cases.

To see how the formula of Du Bois and Du Bois worked by changing the constant, the constant for each individual was determined by dividing the surface area of the body actually measured with the product of $W^{0.425}$ and $H^{0.725}$. The constant thus obtained was $74{\cdot}66 \pm 0{\cdot}23$. When the surface area of the body was calculated with the following equation :

$$\underset{(\mathrm{cm}^2)}{\text{Surface Area}} = \underset{(\mathrm{kg})}{\text{Weight}^{0\cdot425}} \times \underset{(\mathrm{cm})}{\text{Height}^{0\cdot725}} \times 74{\cdot}66$$

there was little variation with the surface area of the body obtained by actual measurements. This equation, therefore, is suggested for the calculation of the surface area of the body of Indian whose physique differ slightly from people of the West.

9. A. SEN GUPTA, N. P. LUNDGREN and P. N. SAHA : *Maximal working capacity in Winter and Summer (Hot Humid) of Adult Healthy Men of Sedentary Habits.*

*Introduction.*

Energy expenditure varies according to the stress of a job. Intensity and frequency of muscle movements to perform work are mainly responsible for this variance. Apart from these two factors the number of muscle units and the mass of muscles involved as well as training influence the metabolic acticity during work. In Sherman's Table energy expenditure for different types of jobs is presented. One really wonders, after a look at the limits, at the reserve capacity of the body to perform work. When lying in bed ielaxed the energy expense is near about 1 K. cal per minute (roughly the energy output of a 70 watt lump); but when one walks up the staircase iapidly the same may shoot up to 20 K. Cal per minute. Assuming the last job to be the limit of one's performance it is obvious that the energy expense may reach 20 times that of resting level in severe stress, approaching limits. It has been observed in Western countries that for short-duration maximal efforts oxygen consumption, which is a direct measure of the intensity of the job, may be 20 times or more than that at resting level. This reserve may not be the same for everyone. Taking the country as a whole it can be broadly inferred that maximal efforts of work will depend on physical fitness of the population as well as the climate. It has been found in Sweden, that in lumber industry the average energy output per day of the workers is 5400 K. cals in winter and 5200 K. cals in summer. India is specially handicapped in climate as well as physical fitness of the population so far as the working capacity is concerned. As for the climate, it has been established that Basal Metabolic Rate of the Indians is roughly 10-15% lower than that of the Westerners as given in Boothby-Sandiford standards. It is also widely known that the Indian population is far behind the Western standards of physical fitness. This is well reflected in lower per capita production of Indian labourers, compared to the western ones. Under these circumstances it was thought useful to investigate into the maximal working capacity of Indians in winter and in summer (hot humid) seasons.

*Experimental Techniques.*

From minute expiratory volume and analysis of expired gases oxygen consumption was determined, which was taken to be the index of working capacity. Work was performed on a bicycle ergometer, against varying frictional loads. Three different loads of 2 lbs., 4 lbs. and 6 lbs. were tried in winter but only 2 lbs. and 4 lbs. were tried in summer. It was found that in summer 6 lbs. load was too strenuous to complete the experiment. These loads were put on a spring balance and were adjusted by means of a wedge. It was obvious that the more the load, the more stressing the job was Pedalling was fixed at a constant rate of 60 cycles per minute. The subject could achieve this rate with the help of a metronome. The loads were tried in ascending order in a continuous experiment. For each load the subject pedalled for seven minutes and after completion of the lower one, he was switched off to higher loads until the maximal effort was reached. Pulse rate, respiratory rate and the subject condition were taken into consideration in order to judge this limit. For each load a five-minute "warming up" period was allowed before expiratory air samples were taken. From the 6th to the 8th minute of each particular load the subject was connected to a big spirometer, to collect the expired air using an assembly of mouth pieces, noseclip, three-way-valve and corrugated rubber tubing. The collection was done for not less than two minutes to have representative gas sample. Pulse rates were counted every minute and respiratory rate was counted on the 6th minute. The highest pulse rate, which was often reached by the 6th minute, was recorded. Minute expiratory volume was determined from the initial and final spirometer readings. Expired air samples were collected in sampling pipettes over mercury and were analysed for $CO_2$ and $O_2$ in a Haldane's Gas Analysis apparatus. Duplicate analyses when agreed within 10% were taken for final assessment of oxygen consumption.

*Material and Data.*

Eleven subjects were chosen from a sedentary group of population after strict examination of their health status. Only healthy subjects were selected for the study. The data on age, body weight, body height and body surface area of the experimental subjects are presented in Table I

TABLE I

PERSONAL DATA OF THE ELEVEN EXPERIMENTAL SUBJECTS

| | Range | Mean |
|---|---|---|
| Age in years ... .. ... | 18 –40 | 29 2 |
| Body weight in lbs. ... . . | 95–159 | 122·1 |
| Body height in inches . .. ... | 62 5-–70·5 | 65·5 |
| Body surface area in sq. meters .. . | 1·40 –1 83 | 1·63 |

All these subjects were performing laboratory duties, and as such they were taken to be of sedentary habits. Out of these only eight could reach the maximal rate in work in winter, and in summer only seven could complete the same.

The experiment was undertaken in the morning before any heavy meal. In winter the environmental temperature was 75°F. D.B. and 65°F. W.B., the corresponding figures for summer were 89°F and 85°F. In the latter season the wet bulb reading was close to that of dry bulb and as such the climate was defined as hot humid climate.

In Table II oxygen consumption for maximal work load and the corresponding load are presented in two different seasons.

The pulse rate plotted against oxygen consumption, taken in absolute terms, shows a scatter. But when it is plotted against oxygen consumption per sq. meter of body surface area the scatter eliminated. This is due to the influence of body size. The linear relations obtained are given by the equations: $Y = 70{\cdot}21 + 0{\cdot}127X$ and $Y = 76{\cdot}65 + 0{\cdot}096X$ in winter and summer respectively, as calculated from the method of least squares; $X = O_2$ consumption $cc/min/m^2$ and $Y$=pulse rate/min. The line for winter has a correlation coefficient, $r = 0{\cdot}909$ where $p < 0{\cdot}001$, and in summer, $r = 0{\cdot}972$ where $p < 0{\cdot}001$, both values being highly significant. Expiratory minute ventilations when plotted against oxygen consumption in two different seasons show a linear relation. Respiratory rates are related in the usual way with oxygen consumption.

## TABLE II

### OXYGEN CONSUMPTION AND CORRESPONDING WORK LOAD IN MAXIMAL EFFORT OF NINE SUBJECTS IN WINTER AND SUMMER

| Subjects | | Winter | | Summer | |
|---|---|---|---|---|---|
| | | Work load Kg/Meters/Min. | $O_2$ consumption Lts/Min. | Work load Kg/Meters/Min. | $O_2$ consumption Lts/Min |
| 1. | M S. ... | 858·6 | 1·796 | 572·4 | 1·501 |
| 2. | B.B.C. ... | ,, | 1·694 | ,, | 1·416 |
| 3. | A.R. ... | ,, | 1·169 | — | — |
| 4 | B.B.S. ... | ,, | 1·496 | 858·6 | 2·255 |
| 5. | A.S G. | ,, | 1·923 | — | — |
| 6. | S.K.D. ... | ,, | 1·498 | 572·4 | 1·453 |
| 7. | S S.S. .. | ,, | 1·431 | ,, | 1·283 |
| 8 | M.K.C. ... | ,, | 1·358 | ,, | 1.·747 |
| 9. | S.B. ... | — | — | ,, | 1·478 |
| | Mean ... | ,, | 1·546 | ,, | 1·590 |

*Discussion.*

(1) From Table I where data on maximal efforts are presented one fact stands clear. Mechanical efficiency was higher in winter than in summer. Mechanical work done for 1 lb. load was near about 143·1 Kg/meters/min. Maximal oxygen consumption for both the seasons was nearly the same, i.e., about 1·5 lit/min. But this maximum oxygen consumption was reached against 6 lbs. frictional load in winter corresponding to 4 lbs. in summer. Defining mechanical efficiency $= \frac{\text{work done in Kg/m/min.}}{O_2 \text{ consumption in litres}} \times 100$, in this particular case the same is 5·55 and 3·6 in winter and summer respectively.

(2) Berggren and Christensen (1950) mention the advantage of taking pulse rate as an indirect measure of energy expense. Lundgren (1950) also emphasised the importance of analysing the pulse rate—oxygen consumption relationship in assessing the physical stress in work. It is imperative that with more demands of oxygen in metabolic work in aerobic conditions there will be a corresponding increase in pulse rate to meet the demand through increased circulation. The slope of the line determines the working ability of an individual. An unstrained subject will have a higher slant compared to a trained one. The steepness of the line is accompanied with maladjustment during work. In winter, though the maximal efforts were higher than in summer, (because all the subjects could complete six lb. load but only one could perform the same in summer), yet the adjustment in circulation was hampered more in winter than in summer.

This may as well be due to haemo-dynamic changes in winter together with lack of acclimatisation. Sen Gupta (1955) observed the importance of acclimatisation in performance of work in digerent climates. Metabolic activity, especially at maximal work level, liberates a large amount of heat inside the tissues. This heat gain needs to be lost at a rapid rate to maintain normal body temperature. In winter the heat gain cannot be lost too rapidly as compared to the summer because of the inefficiency of evaporative loss due to lack of acclimatisation. By convection and radiation mainly this heat gain is likely to be lost in winter. This could be achieved only when heat is conveyed to peripheral tissues by a strong vasodilatory response, which is often accompanied in later stages of work. For rapid transportation of this metabolic heat by blood to the surface a higher pulse rate can be expected in winter compared to summer. In summer when, through acclimatisation, sweat glands dispose heat gain by evaporative loss in sweat the strain on circulation is less than in winter.

The expiratory minute ventilation is related to oxygen consumption in the usual linear way. But in slope there is difference in the two seasons. Usually a higher ventilation is found in winter than in summer for the same oxygen consumption.

The linear relations between oxygen consumption and expiratory minute ventilation, and between oxygen consumption and respiratory rate may be disturbed when approaching maximal work-rate; even in summer the maximal work-rate of winter could not be reached. There are reasons to believe that even if this was reached in summer the linear relation might not be maintained.

*Summary.*

(1) Oxygen consumptions for maximal work in summer and winter reached by nine subjects working on bicycle ergometer are presented, together with their relationships, pulse rate, expiratory minute volume and respiratory rate.

(2) It is found that mechanical efficiency in maximal work is lower in summer than in winter. $O_2$ consumption is higher in summer than in winter for the same stress.

(3) The slants of pulse rate—oxygen consumption line, expiratory minute volume—oxygen consumption line, are steeper in winter than in summer.

(4) The findings are discussed on the basis of associated changes in physiological state in the two seasons.

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DR. W. R. AYKROYD (FAO): *Energy Requirements.*

The problem of energy expenditure and requirements was of great importance to FAO. FAO had the responsibility of making "world food appraisals" based on available food supply data and on estimates of per capita requirements for calories and nutrients. With regard to calories an FAO Committee on calorie requirements prepared in 1949 a report which has subsequently been widely used. The Committee considered the influence on calorie requirements of age, sex, occupation, climate and other factors and made recommendations which can be applied to population groups of different types living in different environments. The factor of climate was difficult to assess because average mean external temperature often failed to correspond with actual environmental temperature.

A second meeting of the Committee on calorie requirements is taking place in May, 1956. This Committee will revise the findings of the predecessor in the light of advancing knowledge.

The estimated per capita calorie supplies for India were amongst the lowest of those recorded for FAO member countries. How far these reflected the malnutrition it was difficult to say. It is gratifying that some attention is being given in India to problems of energy expenditure. Research in this field, though at present somewhat out of fashion, is much needed. It was particularly important in a country like India, where the food situation needs close watching and there is apprehension lest population growth should outstrip food production.

2. D. N. MULLICK and N. D. KEHAR (Izatnagar) : *Energy Metabolism in Farm Animals.*

In calculating, the nutritional requirements of Indian livestocks, foreign data are used so far. Recently, Kehar and associates reported from these laboratories that the Indian cattle require 25% less protein for maintenance than the standard advocated by the foreign workers. It has been reported also that the basal metabolism of the Indian population is less than the western people. It may be likely, that the energy metabolism of Indian cattle may be different from the western standard. It was therefore considered desirable to start a series of investigation to determine the caloric requirements under Indian conditions.

The first observations were carried out on 32 hill steers weighing 250 to 400 pounds. They were on maintenance ration. The equipment for recording the metabolism consisted of an open circuit mask type, to collect the expired air through a two way valve connected with Douglas bag. The collection was continued from 10-15 minutes in the morning after 16 to 18 hours of feeding. The expired gas was analysed for $CO_2$, $O_2$ and $CH_4$. The heat production for 24 hours was calculated from the analysis of gases and respiratory quotient. The resting metabolism per unit surface area was computed from the following equation, surface area $= 0{\cdot}15$ (weight in Kg)$^{0.557}$. The total digestible nutrients was calculated on the assumption that one pound is equivalent to 1814 calories. It was found that all the values were 18 to 20 per cent lower than foreign figures.

These studies have been further extended to determine the effect of different atmospheric temperature from 50 to 100°F on heat production on twelve Hariana Cows, three foreign cross cows and three Murrah buffaloes. The arrangements for experimental were the same as before.

The heat production per hour of Hariana and cross cows and buffaloes decreased with the increase in the air temperature. The mean values were 386, 394 and 485 calories per hour respectively and the mean differences were statisticall significant. The mean values of the calories per hour per square meter surface area were 99·0, 107·0 and 107·0 for Hariana, foreign cross cows and buffaloes, respectively. The differences in the mean figures between the groups were highly significant. The values had a negative correlation with the change of air temperature.

Within the breeds of cows, the foreign cross cows and within the species buffaloes showed higher values.

In another experiment, the resting energy metabolism was recorded in normal adult sheep by using the Benedict Roth respiration apparatus. The average mean value at 17°C was 105 calories per hour per 100 lb live weight.

3. A. SREENIVASAN (Bombay) : *Vitamins and Oxidative Metabolism.*

Since vitamins, more especially the B vitamins, act as regulatory substances in controlling the production as well as utilization of energy from foods, it would follow that efficiency of food utilization may be modified by dietary levels of vitamins. Several recent reports point to an influence of dietary vitamins on the oxidative utilization of carbohydrates and fats and on protein metabolism. In particular, the association of vitamin $B_{12}$ and folic acid with transmethylations, nucleotide synthesis and formate metabolism generally, implies a controlling influence by these two vitamins on a variety of amino acids such as glycine, serine, threonine, cysteine, tryptophan, histidine and methionine.

Two experimental approaches to a quantitive demonstration of vitamin-energy relationships are discussed.

1. Studies on the effects of split-feeding of the protein and non-protein caloric moieties of a nutritionally adequate diet to the albino rat have shown that, in

comparison with the groups that are fed the whole ration in two instalments, those receiving the proteins separately some six hours before the rest of the diet show impaired amino acid utilization and decreased nitrogen retention. An additional supplement of a mixture of B vitamins nearly offsets this disturbance. The observations are explicable on the basis that the vitamins control the efficiency of amino acid utilization and that, in presence of an excess of the B vitamins, the caloric drain on proteins is minimal.

2. In thyrotoxicosis, there is an impairment in the esterification of inorganic phosphate during oxidation. The protection afforded by vitamin $B_{12}$ against thyrotoxicosis is in part at least attributable to a control of this interference and is inferable from studies on conjugation systems involving acetylation of p-amino benzoic acid, benzoylation of glycine and peptidation of glycine, cysteine and glutamic acid (glutathione).

4. DR. B. K. ANAND (New Delhi) : *Energy Metabolism.*

Role of the nervous system in the control of the energy metabolism has been the subject of investigation by various workers. Energy metabolism depends upon the food intake, on the one hand and the various hormonal, chemical and other factors on the other hand. Food intake in the animals depends upon the metabolic requirements. We have previously reported the existence of two mechanisms in the hypothalamus, which control the food intake the lateral hypothalamus controlling the "instinct" to eat and the medial hypothalamus having the "satiety" mechanism, which produces inhibition of the lateral hypothalamus when the animal is satieted after feeding. Work in some other laboratories has tended to show that "specific dynamic action" is the factor which influences these hypothalamic mechanisms and thus the food intake is correlated to the metabolism of the body. We have carried out further work on the higher nervous regions belonging to the limlac system and it appears that the frontal corten in higher mammals is probably the only region which influences the intake through the hypothalamic centres. These centres have also been shown to have fascilitatory and inleitory influences over the feeding reflexes mediated through longer levels.

Mayer reported that the hypothalamic regions are influenced by blood sugar levels. Work done recently in Scandinavia, has shown that lavelled Phosphorus intake by these hypothalamic regions is different from other regions, when the animal is starving. More work is still needed before this picture of nervous control of feeding of energy metabolism will become clear.

## MUSCLE PHYSIOLOGY

5. DR. INDERJIT SINGH : *A Discussion on Muscular Contraction and Relaxation.*

When a muscle contracts, it undergoes several changes such as mechanical, thermal, chemical, volume changes, changes in hydrogen ion concentration electric, osmotic, optical, changes in X-ray diffraction etc. Various attempts have been made to correlate these phenomena in order to elucidate the intimate nature of muscular contraction. Much of the recent work on muscle has centred on the role that ATP plays in muscular contraction. It is possible that ATP will lose its importance as a primer in muscular contraction, owing to the recent demonstrations by Krebs and his associates, and Mommaerts that muscular contraction can occur without the breakdown of ATP. Further Englehardt has claimed that ATP can cause contraction of myosin unassociated with actin.

Two fundamentally opposed theories are advanced to explain the contraction of muscle. In the first, contraction is considered to be due to release of mechanical energy previously stored in the structure. In the second the chemical energy is supposed to be released by the stimulation to enable the muscle to do work, relaxation being considered as a passive phenomenon.

The views on these and other phenomena of muscular contraction are well known, and in the present discussion, I shall present our own experimental findings. Our work has been mainly on unstriated muscle.

If loaded unstriated muscle is stimulated chemically or electrically, it may relax. If however the muscle is unloaded, then some muscles relax whilst others fail to do so. For example guinea pig's uterus and frog's stomach muscle relax when treated with adrenaline, whilst rabbit's gut muscle, which is very sensitive to adrenaline, does not relax at all. Mytilus muscle also does not relax when unloaded.

The next question is whether the relaxation of unloaded muscle is due to pulling on it by the internal elastic structures or not, if this be the case, then the muscle would be loaded, and relaxation passive. To answer this question we have to compare the behaviour of loaded and unloaded muscle towards certain agencies.

These agencies interfere with metabolising in some way or other. If the muscle is asphyxiated or treated with sodium cyanide (1 in 10,000), then loaded muscle may relax profoundly, but unloaded muscle does not relax, on the contrary, it may contract. Similar affects may be produced with sodium azide or iodoacetic acid. These experiments would therfefore dispose off the objection that relaxation of unloaded muscle might be due to internal elastic structures.

This view is supported by further experiments. Asphyxiated of cyanide treated unloaded muscle, will react to adrenaline by relaxation, if it is treated with glucose. To show that this effect of glucose is metabolic, the muscle is then treated with iodoacetic acid, when relaxation of glucose treated unloaded muscle is abolished. These experiments leave no doubt as to the active nature of the relaxation process in some unstriated muscles. Our conclusion therefore, is that in unstriated muscle, there are two systems, in one the relaxation is active, and in the other, passive. This may be related to Szent Gyorgyi's two processes, one exothermic and the other endothermic, in muscle.

In striated muscle, there has been some controversial observations. Ramsay and Street observed relaxation of unloaded single muscle fibres, but A. V. Hill did not find so in whole muscle. We have stimulated frog's rectus abdominis with potassium and acetylcholine and observed no relation in unloaded muscle. So our conclusion is that striated muscle contains only one system, in which the relaxation is passive. Some of our results are in agreement with those of other observers.

Thus we have not found any active relaxation in Mytilus muscle. Abbott and Lowy, in Hills Laboratory, also did not find any heat production in this muscle during relaxation. We have found that adrenaline produces active relaxation in some muscles, and Bulbring has noted increased oxygen consumption, though she has explained it on other lines.

We are next concerned with the contraction process. Contraction of muscle is supposed to be due to folding of the polypeptide chains, but so far no unequivocal evidence of chain folding during contraction has been produced. We have tackled this problem on the following lines. According to modern views, denaturation consists of an alteration of the specific internal structure of the protein wherein the closely folded peptide chains unfold. Similarly, the contraction of muscle is suppose to be due to folding of the contractile protein, so relaxation would be due to unfolding of the muscle proteins. Thus according to these views the process of relaxation would be similar to the denaturation of proteins. In Mytilus muscle, there is evidence, that contraction is due to globular transformation of the contractile protein. This would explain the extreme shortening which such muscles can undergo.

The above experiments also show that cross linkages are necessary for tonic contraction. These cross linkage enable the muscle to maintain tension without expenditure of energy. The effect of urea and salts in causing active relaxation of muscle show that at least two kinds of linkages are concerned—salt linkages and hydrogen bonds.

6. D. P. SADHU (Calcutta) :

Muscle Physiology has attracted the attention not only of Biologists but of scientists in other fields, a most potent phase in the understanding of animal electricity being made by Galvani and Volta, and of laymen and non-scientists such as those interested in the beauties of locomotion, dance-drama and horse races. The mechanical, electrical and other changes accompany the activity in muscle resulting in real or virtual work. The chemical changes are transformed by high-energy phosphate bonds into the mechanical changes of muscle resulting in work. In isometric contraction of muscle where no work is done energy output is less than in isotonic contraction with work (Fann Effect). Investigation into this phenomenon tends to show that the real cause of muscular contraction probably lies in a mechano-chemical reaction whereby chemical and mechanical changes are interdependently integrated through the configuration of myosin or actomyosin chains. It is suggested that actomyosin combines with phosphate and the phosphate compound is the relaxed state of the muscle. During contraction phosphate is released and the free actomyosin chain shortens and as an ATP-ass breaks down ATP into ADP and the actomyosin phosphate is formed. Thus relatation becomes an active and an ATP-dependent process.

Electrical changes produced in heart muscle is recorded by ECG. In goats where is usually an opposite variation in the lead potentials in 1st and 2nd standard leads and this peculiarity is not due to its quadruped posture. Whether this event has any bearing on problems of muscle Physiology is being actively pursued.

7. S. N. RAY (Izatnagar) : *Relation between Vitamin and Trace Element Relation of the B-Group Vitamins to the Trace Element.*

The field of inter-relationship between vitamins and trace elements remains as yet largely unexplored. Though a number of papers have been published on the role of metallic ions in certain enzyme systems involving vitamins, very little has been done to examine the effects of deficiency of trace elements in the intact animals on the production and utilisation of vitamins.

While investigating cobalt deficiency in sheep, it was found that the symptoms exhibited by deficient sheep, resemble certain vitamin deficiency syndromes. Thus lack of appetite and anaemia are common symptoms of vitamin B-Complex as well as cobalt deficiencies. In order to examine whether production of B-Vitamins is disturbed in cobalt deficiency, blood from deficient and normal sheep was analysed for riboflavin, folic acid, pantothenic acid, nicotinic acid and vitamin $B_2$ complex. It was found that the concentration of nicotinic acid and pyridoxin group of compounds was reduced in the blood of deficient animals to the extent of 20 per cent and 45 per cent respectively as compared with the normal contents. A significant reduction in the case of riboflavin was also seen. The folic acid and pantothenic acid contents were not affected.

As in normal ruminants, B-Vitamins are usually synthesised in large quantities in rumen by the microflora present there, this lowering of the concentration of certain B-vitamins in cobalt deficient lambs might have been due to interference of microbial vitamin synthesis in the absence of cobalt. This may also indicate that the production of various members of vitamin B-complex may be brought about by different microflora and cobalt may influence the production of some but not of all the members.

In another series of experiments, cobalt deficient lambs were treated with thiamin and pyridoxin. Lambs given thiamin supplements alone showed increased growth rates but anaemia was further aggravated. Pyridoxin had slight effect on blood regeneration but none on growth. A mixture of thiamin plus pyridoxin was also found to give transient improvements However, when pure vitamin $B_{12}$ became available, dosage with this vitamin alone was found to bring about an alleviation in the cobalt deficiency symptoms. This may indicate that cobalt given *per os* produces vitamin $B_{12}$ which in its turn may help in the proliferation of microflora, synthesising certain B-vitamins

8. DR. SHIV KUMAR : *Vitamins and Trace Elements.*

In human nutrition, the great importance of trace elements in relation to vitamins is only slowly being realised. The trace elements are intimately connected with the proper use by the body of the vitamins, and so should be supplied when treating deficiency diseases. The distribution of trace elements in foods closely follows that of the vitamins so that when there is deficiency of vitamins, there is almost always a deficiency of the trace elements.

Vitamins, particularly of the B group, function as coenzymes in conjunction with the substrate specific enzymes. Cobalt is an integral part of cyano-cobalamin (Vitamin $B_{12}$). Trace elements form parts of enzymatic systems, e.g., Mg of phosphatase, carboxylase, cozymase; Mn of arginase, cholinesterase, Zn of carbonic-anhydrase, and Cu of tyrosinase, ascorbic acid-oxidase, polyphenol-oxidase and laccase. Some enzymes such as arginase, glutaminase, hexosekinase, phosphogluco-mutase, peptidases, phosphatases are activated by divalent metallic ions such as $Mn^{++}$, $Co^{++}$, $Mg^{++}$. Such enzymes can be regarded as metallo-protein enzymes. It is supposed that combination of these enzymes and substrates occurs partly through metallic ions. Thus it is not difficult to understand the probable inter-relationship between the trace elements and the vitamins—the former either forming a part of the enzyme (metallo-protein enzyme) or activating some enzymes, and the latter particularly of the B-group, acting as coenzymes in the enzyme-coenzyme systems mediating cellular metabolic reactions.

9. DR. P. S. SARMA . *Relation of the B-Group Vitamins to the Trace Element Zinc.*

In rats, it has been shown by various workers, that zinc salts fed at high levels are toxic. There is a growth inhibition which is linear with respect to the dosage administered, either as ZnO, $ZnCO_3$ or $ZnSO_4$ and when the dietary level exceeds 1%, there is a considerably enhanced mortality which also sets in very quickly. Under these conditions certain enzymes such as catalase and cystochrome oxidase are inhibited, and alkaline phosphatase is increased, the latter, however, only at much higher levels.

Studies presented herein deal with the toxicity of zinc as $ZnCl_2$ or $ZnSO_4$ for the larvae of the rice moth, *Corcyra cephalonica st.* At levels of 0·2-0·6%, Zn (either as chloride or sulphate) brings about growth inhibition. When the dietary zinc exceeds 1% it becomes rapidly fatal. Liver extract, as well as vitamin $B_{12}$, have been shown to be effective in suppressing the high mortality brought about by feeding 1% $ZnSO_4$. Of the various B-vitamins tested, with a view to finding out whether the B-vitamin content of liver extract was responsible for its beneficial influence, it was found that only vitamin $B_{12}$ and thiamin were effective to any extent in reversing growth inhibition, The second aspect of zinc and B-vitamins relationship presented herein pertains to their lipotropic potencies. The investigations concerning zinc as a lipotropic agent were based on an earlier report in literature wherein such an effect has been demonstrated though only at grossly unphysiological dosages of zinc.

In the present study it has been shown that a fatty degeneration, closely comparable to the corresponding phenomen in rats, could be brought about in insects as well, by feeding cystine. It has been also shown that $ZnSO_4$, in this condition is effective to approximately the same extent as vitamin $B_{12}$ or choline. The possibility has been suggested that it may act better in combination with other established lipotropes. The role of other B-vitamins has also been investigated and compared with that of zinc.

## ROLE OF PSYCHOLOGY IN NATIONAL PLANNING.

### Section of Psychology and Eudcational Sciences

1. DR. ISHWAR DAYAL:

Generally from the discussion it was evident that there is lack of perception of socio-psychological problems arising from a process of change in community and industrial areas of development. It is important that psychology should gear its study toward solving these problems, and much more, in pointing out gaps in Planning in India. It seemed to me that a large number of unrelated problems that were brought out in the discussion, confused the main issue of determining techniques that would help in meeting the problems at the community level in the Planning situation. Experiments of this nature are abundantly found in the project-reports available in literature, especially in reports of Michigan and Boston Community experiments. This divergence in discussion did not enable the group to clarify the role of psychology in National Planning. It is my hope that the section will draw attention of the Planning Commission towards socio-psychological asjects of change and urge serious consideration of problems involved therein.

2. SHRI INDRA SEN: (*Pandichery*).

If National Planning means planning for the development of nation's life, then it becomes, as a whole, entirely a psychological work, the aim in that case being the growth of the life, character and capabilities of the men, women and children of the nation. The amelioration in the environment, building of dams, roads, opening of schools, hospitals and the rest will have then to be clearly conceived and pursued as means.

However, National Planning can be easily conceived as the development of the material resources of the country. Then evidently ameliorations in the environment will tend to become ends in themselves and the human factor concerned will tend to be treated as means.

This approach will not succeed in achieving a true national development, a real strength in national life. It will also create for itself difficulties in getting people's co-operation.

Rightly conceived, national planning is a psychological and educational work and the administrators of the plan will really have to become the educators of the nation.

And if the administrators of the plan seek to become educators of the nation, the entire spirit of the work will change and the difficulties, which are experienced to-day, will tend to diminish a great deal.

3. Dr. G. D. BOAZ : *Guidance and Counselling.*

Three aspects (*i*) Vocational guidance, (*ii*) Counselling or guidance with regard to personal adjustment problems, (*iii*) Treatment of neuroses, psychoneuroses and perhaps Psychoses also.

For I—Occupational information and job dictionary immediate necessity. Education of the parents and realisation of the socialist pattern of society essential. Social value and remuneration of different jobs to be more or less equalised.

For II—The psychologists could be trained and parents manuals on mental hygiene should be published.

For III—To be considered as a specialist proposition.

Use of Rorschack without recognised and adequate training to be severely discouraged.

4. Sri N. L. DOSAJH (Jullundhar) :

The paper discusses how Psychology can play an important role in National Planning—first, by studying the inter-group, political, religious and communal prejudices, hatreds and tensions, psychology can suggest means for resolving them, and thus help in bringing about National unity. Secondly, Psychology, by studying the irrational fears, wrong notions, rituals and anti-social customs of the people, can devise ways and means to resolve them and thus help in bringing about greater happiness in the life of the Nation. Thirdly, the paper shows the importance of mental hygiene clinics and vocational guidance centres in a programme of National Planning.

5. Dr. BIMALESWAR DE, M.A., Ph.D. (London) (Bihar) :

The primary aim of national planning is to achieve all-round improvement in the standard of living of the nation. In planning the major emphasis has always been placed on the economic aspects. But in order that life may be wholesomely lived, economic considerations do not mean everything for man who is a complex psychophysical being. In any national planning, man should be helped to adjust himself wholesomely and adequately to the material progress introduced into his environment. Material progress may be achieved without achieving at the same time corresponding progress in his mental life as a recent poll of the American people has shown. It is a business of Psychology to make its resources available to man so that he may be able to derive the maximum benefit from the outcomes of National Planning.

It is in this context, I think, that the problem of the role of Psychology in National Planning should be considered. The problem has been considered below with regard to two aspects :—First, general, and the second, specific—in relation to the needs of our country.

*General.*

For harnessing psychological service to any development scheme, a survey of the different employers by whom, and the ways in which, the psychologists of the country are being utilised, is the first requirement. Information is essential for an objective appraisal of the existing condition of the country should be available to know if the utilisation of the psychological service in relation to the country's needs and requirements can show any adjustment or not.

Having considered this, the next step will be to make a survey of the fields of interest of psychologists for assessing if the country has adequate psychological resources to cope with the growing needs of the country. Here again reference is made to the 1948 survey of the fields of interest of American psychologists and their percentage in each for the purpose of illustration. Without such a prior survey being made, psychology cannot, I think, play effectively its role in any national planning. In this respect the following fields of interest, which cover perhaps all the different types of service that psychology can offer, may be mentioned :—

1. Experimental Psychologists (including Physiological and Comparative Psychologists).
2. Clinical Psychologists (including remedial workers).
3. Counselling and Guidance workers.
4. Child and Educational psychologists.
5. Personnel Psychologists (including Industrial psychologists).
6. Social Psychologists.
7. Statisticians (Test construction and psychological measurement).

*Specific.*

Against the background given above the role that psychologists in India can play in National Planning has been examined. Two conclusions have been derived from the existing state of affairs :—(i) Lack of adequate resources, that is, facilities and trained personnel, to cope with the diverse psychological needs. (ii) Immediate necessity of opening psychological laboratories and institutes for research and training in psychological service.

6. DR. S. P. GHOSH, M.A., D.Phil. (Cal.) (Delhi) :

Our national planning is more of an industrial pattern. We are getting six or seven steel plants and some small factories by the next few years.

The author feels it is desirable to deal with industrial planning in the field of National Planning. Every industry has got two sides, man and the machine. So long the machinery side of the industry has been stressed, emphasised and the man side neglected. But man in the industry is as much important as the machine. The psychologist can help the industrial planning in the man aspect; in the selection of right man for the right job, detecting accident-prone personnel, studying fatigue and nest pauses, employer and employee relations and so on. Under the auspecies of the Applied Psychology section, Calcutta University, the selection of trade apprentices and skilled workers has been done in various factories e.g. Wimco, National Carbon Co., Ishapore Rifle factory, Chittaranjan Locomotive and so on. The follow-up studies have been found to be useful and some organisations are now intending to set up psychological wing. The Directorate of Ordinance Factory has already started a central psychological organisation, at Calcutta for the selection of workers and other industrial problems.

The experiment on 'work and rest pause' has been studied in one factory with effective results. The problem of accidents has been investigated in the State Transport drivers and Tram drivers, Calcutta and a battery of psychological tests has been developed for detecting accident prone persons. The tense problem of employer-employee relations has been investigated in Bata-Shoe Co., Indian Rubber Factory, West India Match Co., and so on. Some remedial measures have been suggested for improving them

These are some of the experimental studies in the field of industries, done in a united way. Similar lines of action can be implemented in industrial planning of the country for the betterment of production and employer-employee relations.

## GUIDANCE COUNSELLING

1. SHRI UDAY SHANKAR (Delhi) :

Guidance is given to the total personality of the individual child and it is often difficult to separate educational or vocational guidance from personal guidance.

So educational, vocational and personal guidance can be given by the same agency with one or two more special workers. This is all the more essential in this country due to paucity of properly trained staff. But the term "properly trained staff" should not however mean (as is unfortunately thought in some quarters) people trained abroad, nor should the lack of ideal conditions for training deter us from undertaking guidance work. We need not wait till all the techniques or equipments are perfected or the fully trained staff is available. Work is the best training. The dangers of imperfect guidance cannot be more than that of no guidance provided the guidance is given sincerely keeping in view high standard of ethics. This does not, however, imply that anybody can start giving guidance, but the people who understand the dynamics of human behaviour and who have the insight and temperamental leanings in associating with children with some basic study and training can undertake guidance work starting with simpler cases and proceed with more difficult cases as their experience, confidence and insight increases. The first pioneers like Sigmund Freud, Anna Freud, Melanie Klein did not have all the perfect training before they started work. In India also a venture in this field is called for.

2. DR. S. P. GHOSH (Delhi) : *On the Techniques of Guidance and Counselling.*

The whole problem of guidance and counselling can be brought under 3 categories : (1) Personal guidance, (2) Educational guidance, and (3) Vocational guidance. The problem of personal guidance really comes under the jurisdiction of psycho-analysts and psychiatrists. The problems of educational and vocational guidance come under the psychologists and educationists respectively. Educational guidance and vocational guidance are inter-related, one embraces the other. The secondary education commission has put more importance on these two problems. Educational guidance is to be given at the IX standard and vocational guidance at the school leaving stage.

For the educational guidance in view of the diversified courses, the author suggests one general abstract intelligence test Terman-Merrill form 'M' and specific aptitude tests : mechanical aptitude test (Bennett type), Commercial aptitude test (Minnesota type), Scientific aptitude test and a test of Humanities. These four are the main diversified subjects which are going to be implemented very soon into Multipurpose and higher Secondary schools. Tests of Temperament and Interest Inventories are not likely to be useful at this stage owing to imperfection in mental maturity. The author suggests the use of the whole battery of tests at the school leaving stage. He suggests for experimental purpose the following tests and inventories for Vocational guidance.

(1) Intelligence (abstract) :—Terman Merrill form 'M' for group administration.
(2) Intelligence (Concrete) :—(i) Dr. G. Bose's group passalong. (ii) Kohs' Block design for group administration.
(3) Special aptitudes :—(i) Mechanical aptitude (Bennett type). (ii) Manual aptitude (Crockett).
(4) Personality :—(i) Dr. G. Bose's Personality Schedule. (ii) Bernreuter's Personality Inventry.
(5) Interest :—Thurstone Interest Inventory.
(6) Achievement :—(i) School marks, or (ii) Cumulative records.
(7) Interview :—One Scheduled Interview Blank.
(8) Medical examination :—Health report obtained from the school.

The above method will be a screening one.

3. PROF. DURGANAND SINHA (Patna) : *Vocational Guidance in India.*

Certain problems connected with vocational guidance in India have been discussed. It is contended that large scale unemployment, which our country faces, stands in the way of the successful programme of vocational guidance. With too few jobs going, vocational guidance carry little meaning, and is of very limited benefit to the individual. The situation is made worse by the fact that very often recruitment to various employments are not made on the basis of merit, aptitude and training.

Certain studies made at the Institute of Psychological Research and Service, Patna, indicate that vocational preference in young men, as also the choice of subjects for a study to a considerable extent depend upon parental and family pressure, traditional ideas about status and prestige connected with them, and an expectation of earning and promotions. Moreover, our young men have been found to have a very limited range of occupational preference, and many at least, during the college days, have no specific aim in view.

Keeping these factors in mind, the author discusses the role of vocational guidance in this country, and feels that it should be more in the nature of providing occupational information. Full details about the jobs, their nature, conditions of work, hazards and danger, salary, prospects and promotions, prestige and status, qualities and qualifications required, as also periodic survey of employment training for each vocations should be easily available. A national register of occupations should be compiled for helping individuals in making vocational choice. Such a survey should form an integral part of bureau of vocational guidance and employment exchange. Similer service should also be provided by universities and schools for aiding the youth of the country in choosing proper courses. Vocational Psychologists, however, can influence the choice by helping the individual to get an inkling into his aptitudes. In the last analysis it amounts to "self-guidance" to the individuals.

4. SHRI N. L. DOSAJH (Jullundur) : *The Place of projective Techniques in Guidance and Counselling.*

The paper attempts to show how for proper guidance, the knowledge of the emotional aspects of the personality of the counselee is very essential. The paper also discusses the use of projective techniques for uncovering this aspect of the personality. The conclusion arrived at, is that for a good programme of counselling both the feelings and the attitudes of the counselee should be taken into considera-

## THE INDIAN APPROACH TO PSYCHOLOGY

1. DR. AMALENDU BAGCHI (Jalpaiguri) :

This paper gives a short treatise of various phenomena of mind according to Indian Psychology..

1. "A search for 'Panchshila' in the psychological studies of India and the West.
2. The philosophic approach of Vedānta.
3. The approaches of Gautama, the logician, and Kaṇāda, the physicist... no psycho-physics—all introspective psychology—the introspection of a Yogin—various arguments of Nyāya-vaiśeṣika refuting contentions of Cārvāka, the materialist, and modern behaviourists—Kaṇāda's mental chemistry.
4. Mind is feeling enlivening the condition-reflex—two kinds of feelings envisaged in Indian aesthetics—passing feelings based on bio-chemical activities studied in Āyurveda and permanent feelings underlying all sensory-motor activities—eight permanent feelings resolved into four, parallel to the four 'kleśa'-s of Yoga, which again resolve into one basic 'asmitā' or ego-instinct, parallel to the modern biological standpoint in psychology.

5. **A turn into the *Sāmkhya-Yoga-system of Kapila and Patanjali.***
6. Kapila's ego-psychology.
7. The ego-psychology is a triangular gestalt-psychology.
8. The three angles of the ego-triangle are sattva or conscious, tamas or unconscious, and rajas or dynamism.
9. Diagramatic representation of the ego-triangle.
10. How Patanjali envisages working out changes in the basic type-gestalts, called 'karmāśaya', of individuals.

2. SHRI N. K. DASGUPTA (Santiniketan) : *The Role of Consciousness in Psychology with Special References to Indian Approach.*

Since Descartes Psychology became the science of consciousness, Freud has brought consciousness to the lime light giving new and extensive meaning to it. This has uncovered many secrets of human nature.

Dream analysis, at the hands of Psycho-analysts, has revealed many deep-rooted and interesting information about the nether region of our mind. Here Indian Psychology has gone far ahead. Much deeper layers of unconscious mind have been explored. According to Shri Aurobindo dreams may be of two types,—Sub-conscious and Sub-liminal. The investigation of the Western Psychology is confined into the former and has not yet touched even the fringe of the latter. The Sub-liminal dreams are much more significant and powerful in influencing human life and offer a challenge to modern Psychology.

Freud has explored the lower region of the surface mind, but that, too, in fragments only. Jung's researches have gone further ahead. Indian Psychology speaks of a higher consciousness, namely, *Super-consciousness*, which is not only far more extensive and comprehensive, but also illuminating and powerful. Transformation, a Super-conscious force, is more powerful process than sublimation.

According to Shri Aurobindo Consciousness is the essential reality, the fundamental principle of the whole universe. From Matter to Spirit there is but one indivisible consciousness.

3. N. VEDAMANI MANUEL (Madras) : *Indian Psychology as Revealed in Tamil Literature.*

Ancient literature discloses valuable symbolisms and discusses the fundamental problems of the mind. Tolkāppian (written before 1000 B.C.), Tirukkuṛaḷ, and other ancient Tamil works have been consulted.

Tolkāppiam recognises that mental states have to be inferred. It describes 8 emotions. A four fold classification—object, cognition, emotion, and response—is made.

Excess of any emotion and even the usual amount of certain emotions are bad. Love-sentiments are life-principle in man. Character is both internal and external. Will-power is one's wealth.

Dreams express mental conflicts, plans, illusions, compensations and prophetic utterances. They offer release, presuppose sensory experience and use symbolisms. Waking life too is temporary like dreams.

Mental conflict is expressed in slips, self-admotion, projection and compensation. UL or fate is something like personal-racial unconscious. Its action is unforeseen and compulsive.

Both heredity and environment are essential for development. Individual differences and differences between the sexes are recognised. Education means "digging' the water-spring of the child's mind. Sense organs are the means to knowledge; but perceptual knowledge is limited and somewhat deceptive.

The early works assume that life is pleasant. Later, the painful aspect of life is more prominent. Liberation can be obtained through good life, truth, discipline and Grace.

## PROBLEMS IN EXPERIMENTAL EDUCATION WITH SPECIAL REFERENCE TO MATHEMATICS

1. DR. NIROD MUKHERJEE (Gauhati).

In the opening chapter of his Experimental Education, Rusk not only had expressed his confidence in this subject as "without doubt an independent science" but optimistically adhered to the belief that it would continue to dictate its own problems to psychology instead of remaining an appaudage to experimental psychology. But the four decades that have passed since publication• of this book we are ruefully reminded that the joy perhaps was somewhat premature. And, the reasons are not far to seek. Psychology for its progress demands thorough grounding among the workers in this subject in physiology, biology, anthropology and statistics and, also, rudiments of philosophy. Experimental education demands additional knowledge of teaching the young in the school situation. Consequently we do not get a plethora of Ballards and Burts.

Things are unhappily much worse in this country. The writer has come across numerous teachers in education and psychology who are prone to accept Experimental Education as an embarrassing offspring of Educational Psychology breathing for space in the already overcrowded field of psychologies. It is but natural. In a country where half of the school teachers have entered the profession without any prior training of formal nature to expect them to contribute towards the progress of this comparatively new science would be futile. Let us recall what Myers had said half a century ago in connexion with psychology: "I want to protest as strongly as I can against the notion that any useful purpose can be served, . . . . by collecting masses of psychological data with the help of an army of untrained observers." Word for word the statement is applicable to Experimental Education.

To my mind we should now make vigorous attempts to make the utility of this subject known among the teachers distinguishing it from the allied subjects; for this purpose I believe this Section of the Indian Science Congress could be used most suitably. Let us consider a concrete case.

In order to master any scientific subject, fundamental or applied, knowledge of mathematics remains an unquestionable essentiality. More specifically, the role of mathematics as a curricular subject continues to grow in importance in the present social set up in this country when the educational apparatus is being steadily geared to the national progress. Against this background one looks in dismay at the falling standard (or norm?) in the pupil acquirement in mathematics. Some investigations lately made offer us an unsavoury indication that at the matriculation level this subject is fast turning into the worst 'killer'. To lay the blame at the doors of pupil may give breathing space to those responsible in teaching but would hardly offer any plausible solution to the vexing problem. Mathematics *per se* like grammar and unlike literature or geography has little attraction to offer in the emotional sector of learning; the intellectual segment practically covers the whole subject. Consequently it remains one of those subjects which requires not only maximum guidance but, also, efficient guidance. This is possible only when we possess a clear knowledge of regarding the technique of teaching of the subject apart from the knowledge in the subject itself. As it stands today, this requirement is not quite fulfilled. In this paper attempts have been made to lay down some of those principles in the teaching of mathematics made comparatively recently.

# APPENDIX

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